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COMPREHENSIVE FRAMEWORK STUDY

CALIFORNIA REGION

APPENDIX XVII

Navigation

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JUNE 1971

Prepared by:
California Region Framework Study Committee
For Pacific Southwest Inter-Agency Committee
Water Resources Council

CALIFORNIA REGION APPENDIX XVII *Navigation*

The following publications have been prepared under the California Region Comprehensive Framework Study:

Main Report
Appendixes

I	History of Study
II	The Region
III	Legal and Institutional Environments
IV	Economic Base and Projections
V	Water Resources
VI	Land Resources and Use
VII	Mineral Resources
VIII	Watershed Management
IX	Flood Control
X	Irrigation and Drainage
XI	Municipal and Industrial Water
XII	Recreation
XIII	Fish and Wildlife
XIV	Electric Power
XV	Water Quality, Pollution and Health Factors
XVI	Shoreline Protection and Development
XVII	Navigation
XVIII	General Program and Alternatives

(11) June 71

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COMPREHENSIVE FRAMEWORK STUDY,

CALIFORNIA REGION,

APPENDIX XVII,

NAVIGATION,

(12) 267 p.

This report of the California Region Framework Study Committee was prepared at field-level and presents a framework program for the development and management of the water and related land resources of the California Region. This report is subject to review by the interested federal agencies at the departmental level, by the Governors of the affected states, and by the Water Resources Council prior to its transmittal to the Congress for its consideration.

June 1971

Prepared by the
California Region Framework Study Committee

For the

Pacific Southwest Inter-Agency Committee
Water Resources Council

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CALIFORNIA REGION

COMPREHENSIVE FRAMEWORK STUDY

APPENDIX XVII - NAVIGATION

INTRODUCTION

Purpose and Scope

The purpose of this appendix is to survey the future needs for navigation facilities, both commercial and recreational, in the California Region. This appendix is concerned solely with the major navigable waters of the Region. These navigable waters include the coastal waters, the Sacramento and San Joaquin Rivers and interconnected streams, and the Colorado River contiguous with the region's boundary. This report does not cover recreational boating on inland waters, which is included in Appendix XII: Recreation.

Basic material in this appendix was derived using BASE PLAN population projections, as discussed in Appendix IV: Economic Base and Projections. The effects of other population projections on navigation in the Region are discussed in Supplement A, "Alternative Projections".

Procedures and Assumptions

Existing conditions were inventoried from available reports on navigation facilities, and by field reconnaissance where reports were not available. Estimates of future requirements for commercial navigation facilities were based upon projected quantities and types of waterborne commerce likely to move through the region's ports and waterways. Estimates of future requirements for recreational navigation facilities on navigable waters were based upon previous studies of recreational boating needs developed by the Corps of Engineers and the State of California, adjusted to Base Plan population projections. Estimated costs of the navigation plan were based on preliminary estimates of the protective features, dredging, and corollary improvements required. Federal, non-Federal, and private costs directly associated with navigation were included.

For the purposes of analysis, it was assumed that existing regulations and on-going procedures governing the planning, construction and operation of navigation facilities would continue in effect throughout the study

period. These existing regulations and procedures concern environmental quality; water quality; public health and safety; fish and wildlife; and coordination with Federal, State, regional and local agencies and with the public at large. Existing regulations and procedures are described in detail in Appendix III: Legal and Institutional Environments.

Relationship to Other Parts of Report

This appendix is a unit of the Comprehensive Type I Framework Study for the California Region. The California Region includes the State of California plus a small portion of the State of Oregon, as shown on Map 1. The Framework report has 18 appendices, assigned to appropriate technical subcommittees. The first three appendices are "History of Study," "The Region," and "Legal and Institutional Environments," and are essentially background material. The next four appendices are "Economic Base and Projections," "Water Resources," "Land Resources and Use," and "Mineral Resources": these four appendices present basic information on the Region. The next 10 appendices are "Watershed Management," "Flood Control," "Irrigation and Drainage," "Municipal and Industrial Water," "Recreation," "Fish and Wildlife," "Electric Power," "Water Quality, Pollution and Health Factors," "Shoreline Protection and Development," and "Navigation." These 10 appendices may be termed functional appendices, as each deals with a particular recognized phase of water and related land use, development, or management. The final appendix, "General Program and Alternatives" brings together the resources and demands, or goals, and presents a framework plan and alternative plans of how the demands or goals can best be satisfied or achieved.

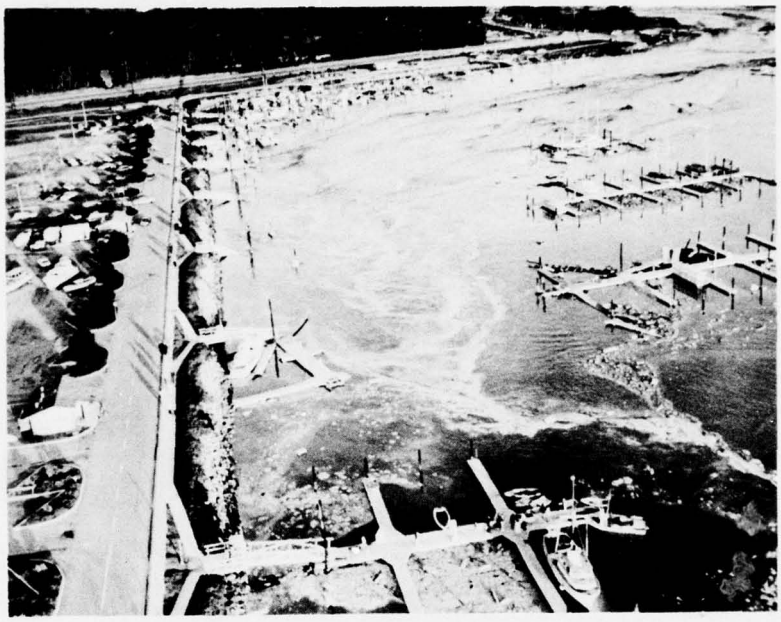
Several study areas covered in other appendices are related to the Navigation appendix. These relationships are discussed in the following paragraphs.

LEGAL AND INSTITUTIONAL ENVIRONMENTS

Existing Federal and State statutory authorities are generally adequate for the implementation of present navigation policies, but additional legislation may be required to support future policy modifications. The studies and reappraisals recommended in Appendix III: Legal and Institutional Environments, would provide valuable guidance in evaluating the need for policy modifications.

FLOOD CONTROL

Harbors are usually constructed in bays, estuaries, and the mouths of rivers, because these sites are more economical. The harbors then are subject to silting from sediment carried by rivers and streams, and are vulnerable to damage from floods. The destructive effects of uncontrolled flood waters upon a harbor were demonstrated during the



Ventura Marina was severely damaged in 1969 when storm runoff and failure of the levees permitted the Santa Clara River to leave its channel. (Corps of Engineers photo)

Damage to boats and facilities at Santa Barbara Harbor was caused by the 1969 offshore oil spill. (Corps of Engineers photo)

1969 storms in the South Coastal subregion, when the Santa Clara River broke through its levees and severely damaged the $8 million Ventura Marina, which is located just upcoast of the river's mouth.

RECREATION

The recreation directly afforded by recreation navigation has been evaluated in this appendix. Other recreational potentials, however, exist in both commercial and recreational harbors. The waterfront attracts many visitors who enjoy watching ships and the bustle of a harbor. The recreation afforded by a marina is not derived solely from boating; much recreation is derived from non-boaters watching boats. This recreational environment could be enhanced by vista points, picnic and rest areas, maritime museums, and exhibits at both recreational and commercial harbors. Coastal values and the recreational value of islands are discussed in detail in Appendix XII: Recreation.

FISH AND WILDLIFE

The most economical sites for harbors are estuaries and bays. These areas are also of great importance to marine life and as sanctuaries, feeding grounds, and resting places for waterfowl. The impact of navigation improvements on fish and wildlife, through destruction of estuaries, tidelands, and marshes, cannot be measured in economic terms. Disposal of dredged material in tidelands and in the open ocean also can have an adverse effect on fish and wildlife.

WATER QUALITY, POLLUTION CONTROL, AND HEALTH FACTORS

Water quality requirements in commercial and recreational navigation features are somewhat different. Although pollution of commercial harbors does not impair their function for navigation, it does impair other beneficial uses, such as sustenance of fish and marine life, industrial water supply, and general recreation. Recreational navigation facilities are always adversely affected by pollution. Pollution and debris which damage paint and fittings on small craft seriously impair the quality of the recreation. Many multiple-purpose small-craft harbors provide areas for water-contact sports, and require water of even higher quality than that required for recreational boating. Major sources of pollution in harbors are industrial and domestic waste discharges, oil spillage, untreated sewage discharge from vessels, and exhaust discharge from small craft. Another interrelationship between water quality and navigation is in dredging and the disposal of dredged material. Material dredged during harbor construction or maintenance is disposed of primarily: (1) in open water within designated disposal areas; (2) in diked disposal areas: (3) on adjacent areas for fill; or (4) on beaches for nourishment or widening. Disposal of material in open water, in diked areas, or for fill, required careful control to avoid unacceptable pollution. Material used for beach nourishment or widening is selected

material with little organic content and a minimum of silt and fines. Dredging and filling can change water circulation patterns, affect reaeration, and alter biological activities directly affecting water quality.

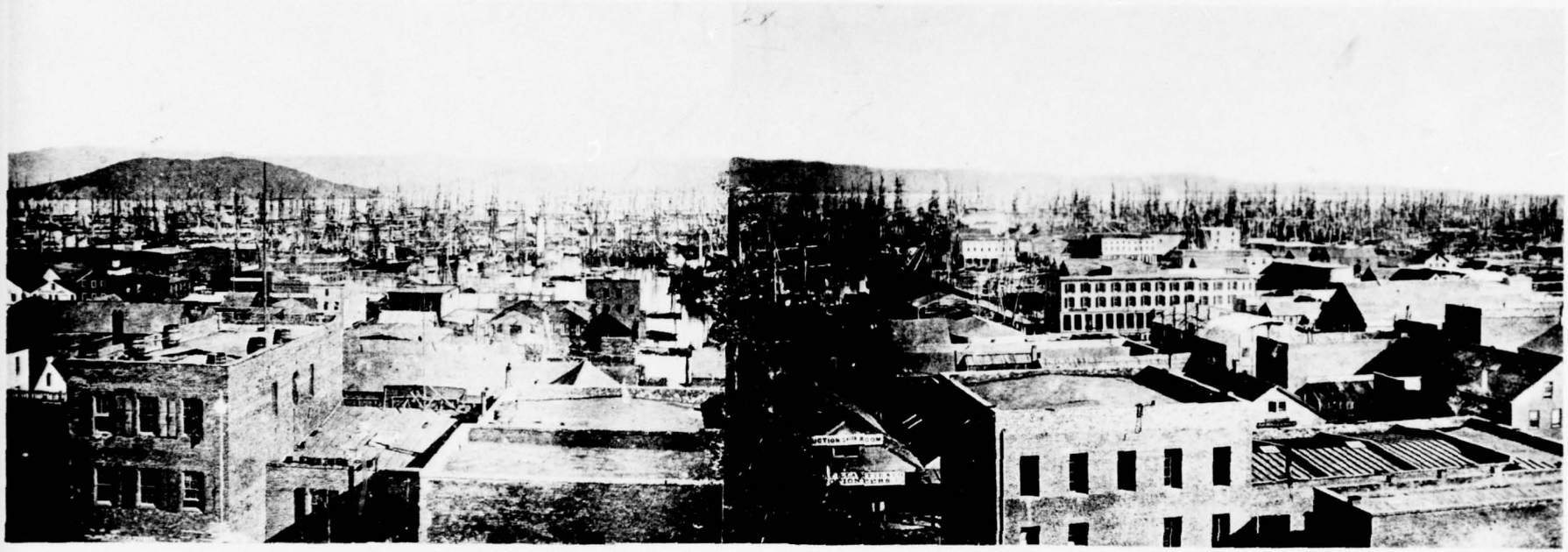
SHORELINE PROTECTION AND DEVELOPMENT

In most instances, construction of coastal harbors has had an effect upon littoral processes along the adjacent shoreline. Entrance jetties impede the littoral stream, causing deposition on the up-drift side and erosion on the down-drift side. Breakwaters parallel to shore create areas protected from wave energy, and material accretes in these areas. Costly shoreline protection and harbor maintenance work often result from harbor construction: on the other hand, harbor dredging has been a valuable source of beach material, particularly in the South Coastal subregion where the natural sediment contribution from streams has been reduced by flood-control improvements.

History of Regional Development

The historic development of transportation in the California Region has been determined by the region's physiography and by its resources. Major physiographic features of the region are as follows: a mountain fringe along the coast; another mountain system along the east border; a great valley between the mountains and enclosed by them; and outside of this, a great area of basins, barren deserts and mountains. The great valley is drained by the region's major navigable stream system, the Sacramento and San Joaquin Rivers, which reach the sea through San Francisco Bay. The coastline is generally rocky and affords few natural harbors. Further, the coast is convex, which increases sailing distances between port; and is marked by many dangerous rocky headlands. The Sierra Nevada, along the east border of the region, combined with the formidable deserts to the south, raised an imposing barrier to overland transportation. The isolation of California from the remainder of the world, during the early part of its history, delayed development of transportation in general. The journey around Cape Horn was as dangerous as the long overland crossing from the eastern seaboard was difficult.

The history of transportation in California can be considered in two periods -- the pre-gold rush period of Spanish exploration and occupation, and the post-gold rush period of colonization and development. The lower Colorado River was discovered by the Spanish in 1540, but the explorers did not penetrate California. In 1541-43, Juan Rodriguez Cabrillo and his successor, Bartolome Ferrelo, explored probably the entire coast as far north as Oregon. In 1579, Sir Francis Drake repaired his ships in Drake's Bay, north of San Francisco, and in 1602-03, Sebastian Vizcaino further explored the coast, discovering the bay of Monterey, but missing San Francisco Bay. For three centuries after the original



This forest of masts is a part of the 500 ships abandoned in San Francisco Bay in 1850 when their passengers and crews took off for the goldfields. (Photo courtesy of the California Historical Society and Eastman House)

explorations, fear of Russian or English occupation and consequent danger to Spanish colonies in Mexico caused the Spanish to take definite action to occupy Alta California. This occupation reached its climax during the period 1769 to 1823, when the missions, 21 in all, were established. By 1823 Mexico had won its independence from Spain and assumed control of California. The seat of government was at Monterey, and the missions were linked by the overland Camino Real, or King's Highway. During this period, California was sparsely settled and largely self-sufficient, trading hides and tallow for the few necessities not produced at the missions, ranchos and pueblos. Isolated from Mexico by a long and difficult sea journey, or by tedious and dangerous overland routes, the colony drifted away from the parent country.

During the mission period, foreign fur trappers, attracted by the lustrous pelt of the sea otter, worked along the coast. Man's greed for the pelt of the sea otter was responsible for the Russian occupation of Alaska and California, the early voyages of the English to British Colombia, and the first contact of colonists with California. The animals were hunted almost to extinction by 1820. Under Spanish provincial law, foreign vessels were forbidden to trade along the coast; however, Spain was unable to enforce this prohibition. Active, though sporadic, trade with Yankee fur-hunters and whalers developed, and was encouraged by the Californians. In the early 1840's, there were upwards of 50 vessels on the coast trading in hides and tallow, and flying the flags of the United States, various European countries, the Sandwich Islands, and Mexico. Alta California gradually slipped away from Mexican control, and in February 1848, by the signing of the Treaty of Guadalupe Hidalgo, California became a territory of the United States. Two weeks prior to signing of the treaty, gold was discovered at the saw mill belonging to John A. Sutter.

By the close of 1848, the news of the gold discovery had reached the world. The migration to California that followed was the greatest of its kind in the nation's history. Throughout the winter, the overland routes were closed by snow, so the first great influx came by sea. It is estimated that 80,000 men reached the coast in 1849; about one-half of them coming by sea. Ships deserted by their gold-hungry sailors crowded the bay at San Francisco; there were 500 abandoned vessels in the bay in July 1850. The overland migration, when it began, was even larger than that arriving by sea. The wagons followed the early trails laid out by the mountain men and fur trappers, and the difficult trails blazed across the deserts and over the Sierra to the gold fields. Prior to the discovery of gold, California had no transportation demands that could not be met by horse, ox-cart, or sailing ship. The gold rush created a demand for more convenient ways of getting around. The first artery opened was the river line from San Francisco to Sacramento. In 1854, the California Steam Navigation Company was organized and, besides dominating inland navigation on the river, provided coastal service to ports in northern and southern California and at the mouth of the

Colorado River. Steamer service flourished until 1869 when the continental rails were joined at Promontory Point, reducing boat steamers and overland stages to a subordinate role.

Transportation facilities in California rapidly increased after completion of the first continental line. By 1900, all parts of the State were linked by rail and by connections to the east. Rails cross the Sierra over passes 5,000 to 7,000 feet and the lower southern mountains over passes 2,500 to 4,100 feet high. Interstate and intrastate highway systems contributed to the growing use of motor vehicles for passenger and freight transportation. Development of man-made harbors at Los Angeles-Long Beach and the interior deepwater ports of Stockton and Sacramento supplemented the natural harbors in San Diego and San Francisco bays.

Recreational boating started in the Region in the 1800's, when many of the major yacht clubs were founded. The recreational boating fleet increased generally at the same rate as population until after World War II. Between 1954 and 1958, pleasure boat ownership far exceeded the population growth rate. During this period, relatively inexpensive mass-produced boats of all types became available, and both leisure time and expendable income increased rapidly. Since 1958, the growth rate for boat ownership has more closely approximated the population growth rate. It is interesting to note that many of the bights and lees that afforded inhospitable refuge to explorers, fur trappers, hide ships, and lumber schooners are being developed as small-craft harbors in this later age.

In 1970, only 135 years after Richard Henry Dana sailed the coast on hide ships, a harbor for over 2,000 pleasure boats was being built in the lee of the point that bears his name; and the miserable landing at San Pedro, which he called "the hell of California," handles more tonnage then any other harbor in the State. The beautiful bay at San Francisco, which Dana so admired, accommodates a complex of ports and harbors, and ocean-going vessels ply the Sacramento and San Joaquin Rivers.

REGIONAL SUMMARY

General

The California region has a variety of navigation features along its 1070-mile-long ocean shoreline, within its natural bays and estuaries, and on the Sacramento-San Joaquin river system. The region is fortunate in having two large natural bays and a major river system that provides access to the rich heartland of the region. The region's two major population centers, the San Francisco and Los Angeles metropolitan areas,

have developed major commercial navigation facilities, but in a very different manner. The San Francisco area developed as a center of population and commerce because of its location, the bay providing both a harbor and a gateway to the great central valley. The Los Angeles metropolitan area developed as a center of population in spite of its location, and when its growth required facilities for commercial navigation, a man-made harbor was constructed on the open coast in the lee of a headland. In 1965, the region's ports and waterways handled almost 100 million tons of waterborne commerce -- about 8 percent of the total waterborne commerce of the United States. The California region also permanently berthed about 42,000 small craft in the coastal harbors and along the navigable waterways. It is estimated that recreational boating on the region's navigable waters, by both berthed and trailered boats, afforded about 25 percent of all the boating recreation in the region.

Existing Development

COMMERCIAL NAVIGATION

In 1965, almost 80 percent of the region's waterborne commerce was handled through the port complexes in San Francisco Bay (45.5 million tons) and Los Angeles-Long Beach harbors (32.8 million tons). Other facilities in the Region, ranked by total waterborne commerce handled in 1965, are the offshore petroleum terminals of the Central and South Coastal subregions (13.3 million tons), the inland ports in the Delta-Central Sierra subregion (4.9 million tons), San Diego Harbor (1.5 million tons), Humboldt and Crescent City harbors in the North Coastal subregion (1.0 million tons, together), and Port Hueneme in the South Coastal subregion (0.1 million ton). The location of these facilities is shown on Map 1, following this regional summary.

Federal navigation projects have been constructed, or are authorized, at all of the harbors and ports mentioned and along the inland waterway connecting San Francisco Bay with the ports of Stockton and Sacramento. Federal navigation projects within San Francisco Bay are numerous and complex, and are discussed in detail in the San Francisco Bay subregion section of this appendix. The offshore-petroleum facilities in the Central and South Coastal subregions are private developments.

Minor amounts of waterborne commerce, including fish and shellfish, have also moved through other coastal Federal navigation projects located at Noyo Harbor, Bodega Harbor, Moss Landing Harbor, Monterey Harbor, Morro Bay Harbor, Port San Luis, Santa Barbara Harbor and Newport Bay Harbor. (See Map 1.) These navigation projects are all used by both commercial-fishing boats and by recreational boats.

Waterborne commerce consisted of every type of traffic. Terminology used in respect to type of traffic in this appendix is consistent with that defined in "Waterborne Commerce of the United States" published by the Department of the Army. The terms applied to the major types of traffic are defined as follows: Foreign imports and exports consist of traffic between the United States and foreign ports, including the Canal Zone; coastwise receipts and shipments consist of domestic traffic receiving a carriage over the ocean, and include commodities shipped between Alaska, Puerto Rico or Hawaii and California, as well as commodities shipped between California and the other conterminous states; and internal receipts and shipments consist of traffic between ports or landings where the entire movement takes place on inland waters. The only significant internal traffic in the region is that moving within San Francisco Bay and up the Sacramento-San Joaquin river system.

Every commodity group is represented in the region's waterborne commerce. Petroleum and petroleum products comprised almost 70 percent of the region's total waterborne commerce in 1965. The other four major types of commodities were metals, chemicals, lumber and agricultural products.

RECREATIONAL NAVIGATION

The recreational fleet is berthed in non-Federal marinas within Federal deep-draft navigation projects; in Federal small-craft navigation projects; and in numerous non-Federal marinas located along the Sacramento-San Joaquin river system and on the Colorado River, within San Francisco Bay, and in coastal facilities. The recreational fleet is heavily concentrated in the San Francisco Bay and Los Angeles metropolitan areas. Major Federal small-craft projects (in addition to those shallow-draft harbors previously mentioned in the paragraphs on commercial navigation) are Marina del Rey, Redondo Beach King Harbor, Mission Bay Harbor and Oceanside Harbor. (See Map 1.) Non-Federal public and private interests have constructed facilities on the navigable rivers, in the bays, and at coastal harbors and other protected coastal sites for the launching of trailered recreational boats.

Future Needs

COMMERCIAL NAVIGATION

Present trends in ship design and in cargo-handling techniques indicate that major improvements will be required if the region's ports and waterways are to operate efficiently in the future. Specialized vessels designed to carry containerized cargo are replacing general cargo vessels on many trade routes, and numerous commodities are being shipped as dry bulk on specialized carriers. Petroleum tankers with drafts of 50 feet, which cannot be accommodated in the region's existing ports, are presently being constructed in the world's shipyards.

Supertankers with drafts in excess of 70 feet are foreseen for the future. This trend toward extreme-draft tankers is particularly significant in the region because of the projected future volumes of petroleum and petroleum products to be accommodated. As shown on Figure 1, which summarizes the region's projected waterborne commerce by simplified commodity categories, projected petroleum and petroleum products represent about 60 percent of the region's total waterborne commerce in the year 2020.

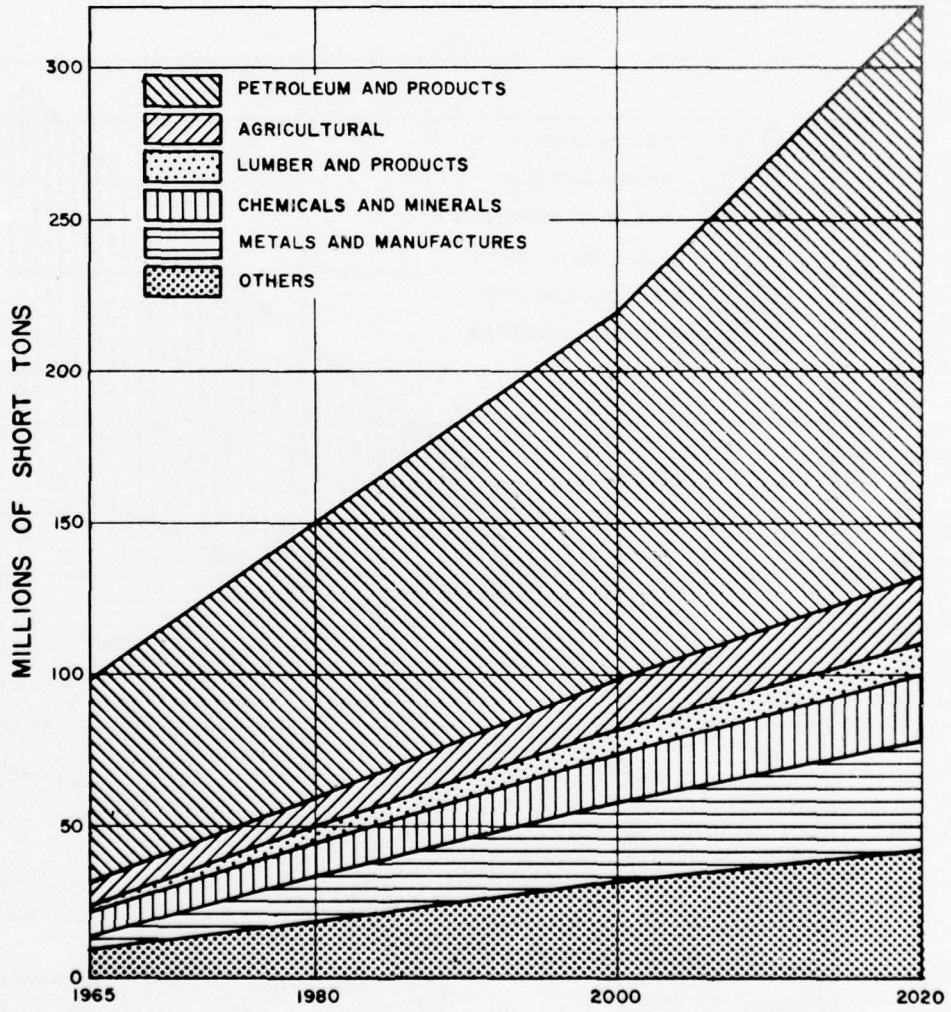


FIG. 1-SUMMARY OF CALIFORNIA REGION WATERBORNE COMMERCE, BY TYPE OF COMMODITY.

This graph, and those on the following pages, were prepared by summarizing the data contained in tables concerning waterborne commerce in the subregional chapters.

The projected distribution of waterborne commerce by type of traffic indicates a pronounced growth in foreign traffic, particularly foreign imports, to meet the needs of the region and other areas of the United States served by the region's ports. Much of this trade will be with the Pacific-Asian area. Figure 2 summarizes the region's present and projected waterborne commerce by type of traffic.

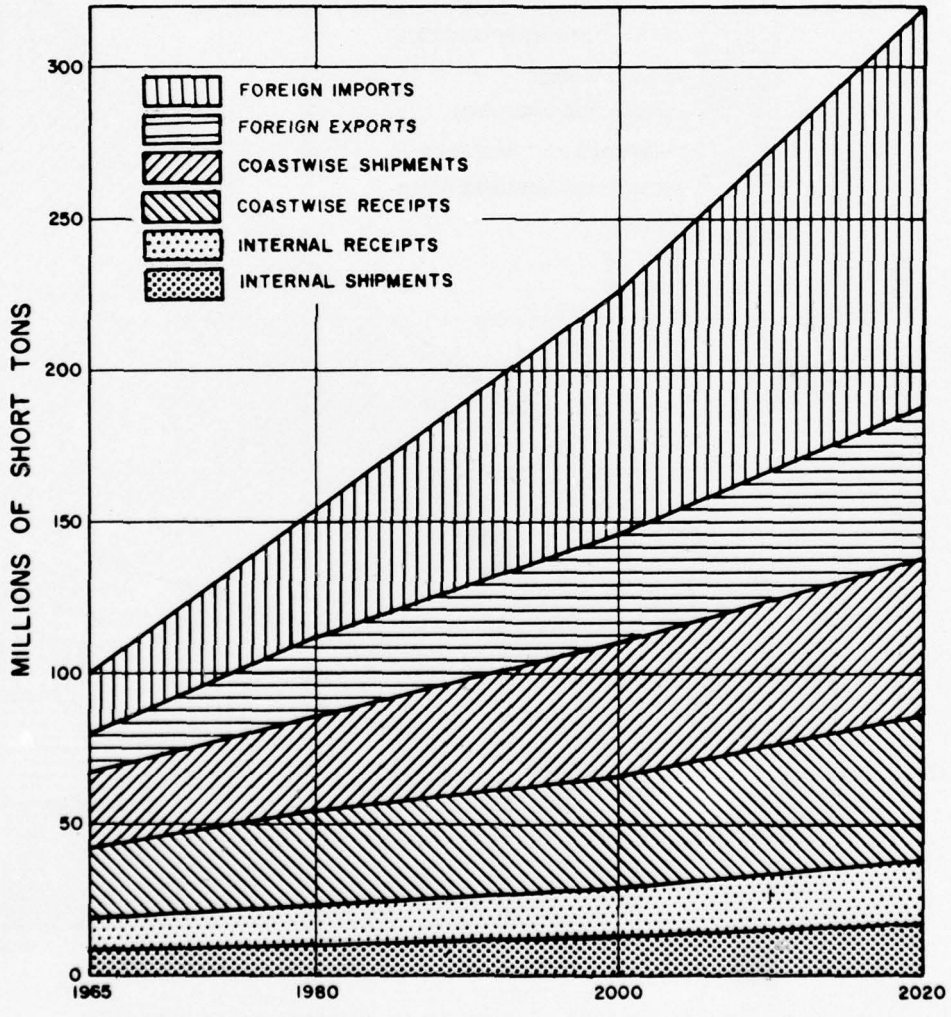


FIG. 2 - SUMMARY OF CALIFORNIA REGION WATERBORNE COMMERCE, BY TYPE OF TRAFFIC.

This petroleum terminal in San Francisco Bay will accommodate a supertanker with a draft of 35 feet. The supertanker of the future may have a draft of 70 feet. (Corps of Engineers photo)

Container cargo terminals like this facility at Oakland Harbor need extensive back-up land to support a single ship position. Contrast the container marshalling area in the foreground with the breakbulk warehouse areas at other slips.
(Photo by Sunderland Aerial Photographs)

Although it was not considered in preparing these projections, the concept of the United States as a land bridge linking Asian and western European ports has been much discussed. This concept involves transshipment of containerized cargo between Pacific Coast ports and Atlantic Coast ports by rail; should this concept prove valid in the future, the impact upon the region's ports could be mammoth.

Shipment of commodities through major regional ports is the trend of the future. The region's present deep-draft navigation features and terminal facilities will require considerable improvement if they are to service the expanding population of the areas tributary to the ports and if the region's major ports are to retain competitive status with other world ports. Waterways will require deepening, widening, and extending to accommodate ever-larger vessels; land areas will require major expansion; and a substantial investment in modern terminal and transfer facilities will be necessary. The revolution in vessel design now occurring is being matched by radical changes in cargo-handling techniques that permit a single ship position to load and unload an increasingly large tonnage of cargo in a decreasingly short time. These specialized bulk-loading and container handling terminals require far greater acreages of backup land per ship position than do the conventional break-bulk general-cargo berths.

The major impact of the required improvements will occur within the port complexes in the San Francisco Bay and South Coastal subregions, which together handle about 85 percent of the region's waterborne commerce at present, and are expected to handle about 95 percent by the year 2020. The distribution of the region's present and projected waterborne commerce, by subregion, is shown in Figure 3.

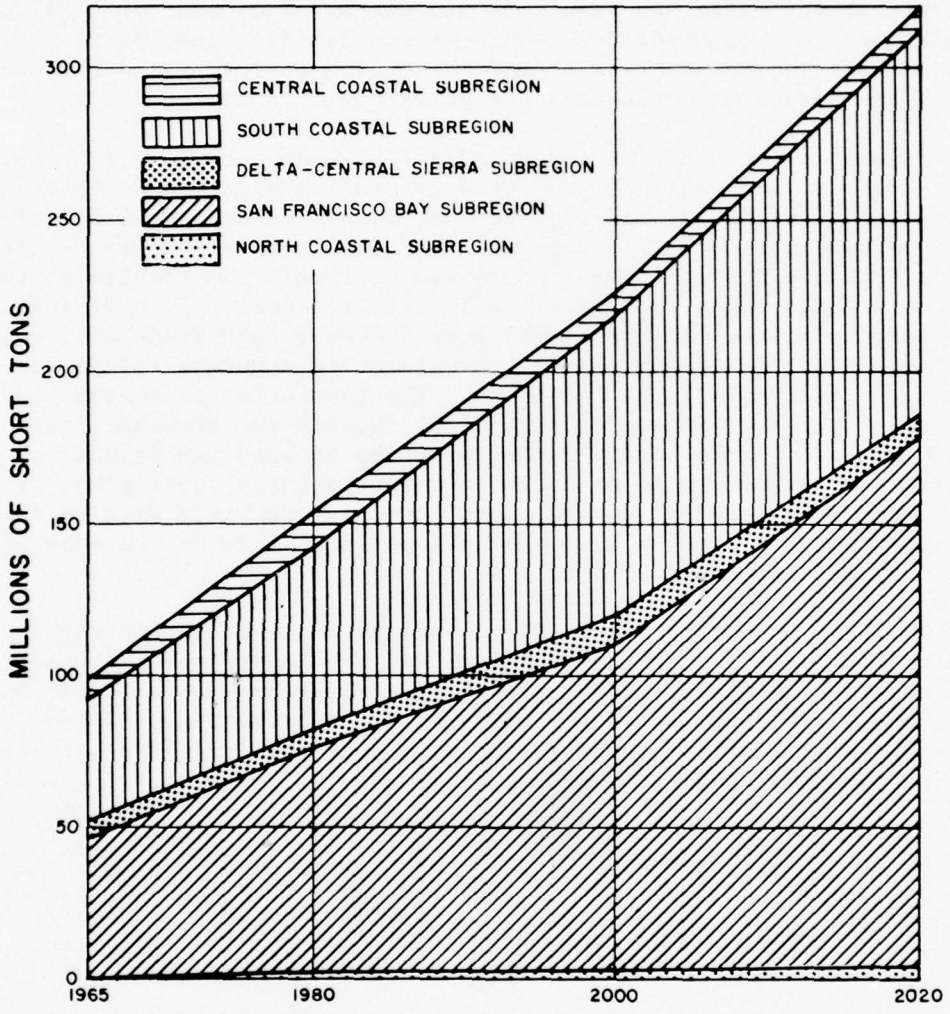
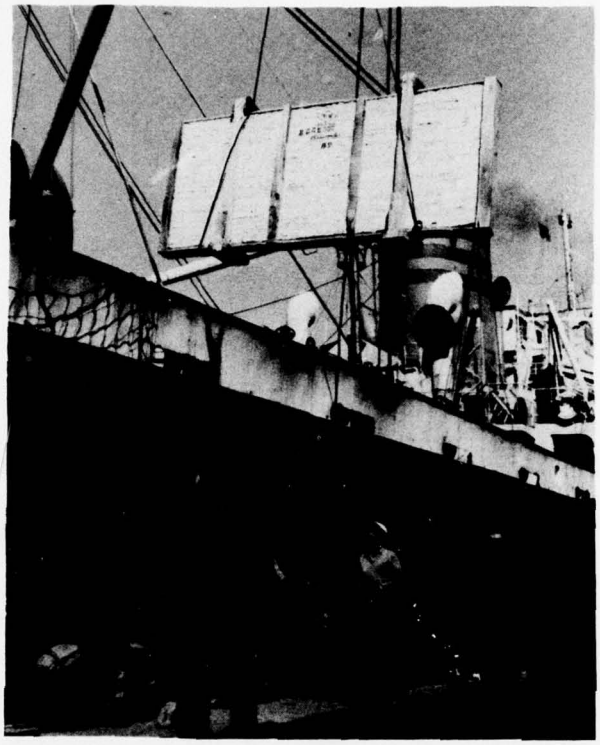


FIG. 3 - SUMMARY OF CALIFORNIA REGION WATERBORNE COMMERCE, BY SUBREGION.



← Break-bulk general cargo often consists of shipments of diversified items, and is generally handled by ship's tackle.

(Port of Los Angeles photo)

Automobiles are one type of unitized general cargo. →

(Port of Los Angeles photo)

A possibility exists that future population growth will require increased use of protein foods from the ocean, resulting in "farming" of the sea. Should this utilization of the ocean develop, expanded facilities for commercial fishing could be required.

The 1965 tonnages of waterborne commerce and projected tonnages for the years 1980, 2000, and 2020 through the region's commercial navigation facilities are summarized in Table 1. Projected waterborne commerce, by commodities, is presented in the subregional chapters. Commodity groupings used in "Waterborne Commerce of the United States", prepared by the Department of the Army, Corps of Engineers, were not rigidly adhered to in all subregional commodity projections, in order that characteristics of particular harbors or port complexes could be more specifically presented.

RECREATIONAL NAVIGATION

Projections of future boat ownership were based on methodology used in the "California Small-Craft Harbors and Facilities Plan, Comprehensive Report," dated March 1964, prepared by the State of California. Adjustments have been made to reflect subsequently available data. Future needs were assessed in terms of permanent berthing facilities, launching facilities, and transient and destination facilities.

Future needs for berthing were estimated by applying ratios of number of berthable boats per 1,000 population to the Base Plan population projections. These ratios varied by subregions, to allow for congestion, income, climate, accessibility to boating waters and other factors. Ratios of berthable boats were projected in the range 3.4 to 4.0 per thousand population in the year 1980; 4.0 to 5.0 in the year 2000; and 5.0 to 6.0 in the year 2020. In 1965, both the Puget Sound area of Washington and areas in southern Florida produced about 7.5 berthable boats per thousand population. These areas are believed more conducive to recreational navigation than the California Region because of their extensive inland waterways: therefore lower ratios were selected as a basis for the projections in this appendix.

The number of berths available within facilities existing in 1965 was inventoried: and the berthing capacity of existing facilities, as well as facilities definitely programmed for construction, was determined. The berthing needed, in excess of that which could be provided within existing facilities, was used as a measure of the amount of construction required to provide protected water areas within which berthing needs could be met. Table 3 summarizes requirements, in unit berths.

Future needs for trailered-boat facilities were based upon estimated use of ocean waters by trailered boats, as contained in the "Comprehensive Report" and modified to reflect subsequently available data. Needs are

presented in terms of equivalent launch ramp lanes, defined as a launch ramp 12 feet wide, or a hoist with equivalent capacity. In inland areas, a capacity of 40 boats per ramp was used. In the inland areas, facilities consist almost entirely of ramps; and there are relatively few high-capacity hoists; this condition is likely to persist. The ramps are less elaborate than those found in many coastal harbors, and peak-day use does not vary markedly from normal weekend-day use. In coastal areas, the facilities are generally more sophisticated, and peak-day use on summer holiday weekends is considerably higher than on normal summer weekends. A degree of crowding during the limited periods of peak-use in coastal areas is considered acceptable. The required number of launching lanes to provide access to the navigable waters of the region is summarized in Table 3.

Boating on the region's coastal waters and, particularly, intracoastal cruising by recreational vessels is severely constrained by the lack of a chain of harbors of refuge along the region's coast. Transient and destination facilities were evaluated in terms of moorings or their equivalent. These moorings would require all-weather protection and necessary support facilities within harbors of refuge or multiple purpose harbors. This coastal chain of harbors would also enhance recreational opportunities by providing new boating destinations, encouraging cruising, and opening presently under-utilized fishing grounds to recreational fishing. The projected needs for transient moorings are summarized in Table 3.

Means to Satisfy Future Needs

GENERAL

In order to have a basis for the required cost estimates, it was necessary to develop a fairly definite plan of improvement for both commercial and recreational navigation. Navigation features, such as breakwaters and channels, are difficult to cost unless a specific location for the feature is assumed. The plan set forth under this heading is considered an acceptable and feasible means to satisfy future needs, however, it should be emphasized that details of this plan were developed primarily as a basis for cost estimates. These details, such as specific sites for harbors or specific lengths of channels, could be subject to considerable change as a result of later studies. Corollary changes in the cost estimates would then occur.

The costs of providing aids to navigation have been included in the cost estimates. Aids to navigation are provided as a normal part of structures in coastal waters that would otherwise be a hazard to navigation.

COMMERCIAL NAVIGATION

Because of the impacts on the economy of the Region and adjoining areas served by the Region's ports, it was deemed desirable to fully satisfy the demand for facilities to handle the projected waterborne commerce. It became evident, early in the study, that these demands could be met through improvement and development of existing ports and waterways.

These improvements would consist of deepening, widening and extending navigation channels, turning basins, anchorage areas; extending protective breakwaters and jetties, training walls and levees; and providing required aids to navigation. Additional non-revenue producing features, such as land development, retention works, and dredging of berthing basins, would be required. Although the Region's future needs for deep-draft navigation facilities can be met primarily through modification of existing harbors and waterways, there is an apparent need for four new terminal ports - three in the San Joaquin-Sacramento system and one in San Francisco Bay. These ports are discussed in more detail in the appropriate subregion chapter of this report. The needs of light-draft commercial fishing vessels would require construction of a chain of shallow-draft harbors of refuge along the ocean shoreline; these harbors of refuge are discussed under "Recreational Navigation". The gross needs for commercial navigation, excepting the harbors of refuge, are summarized in Table 2.

The only major alternative to conventional port development considered was the possibility of developing offshore buoy-type petroleum terminals in lieu of deepening channels to onshore terminals. Additional detailed studies, beyond the scope of this report, would be required to determine if offshore installations could function satisfactorily in the open ocean along the California coast. These studies should also evaluate the consequences of accidental oil spills. Some evidence to date indicates that the most immediate damage to the biological community probably occurs in the intertidal zone. An oil spill in the open ocean may be less damaging than if the same spill were to occur in a harbor containing mudflat and marsh area. Studies should also be made of the hazards and difficulties associated with mooring supertankers at offshore terminals: traffic problems during storm conditions; and the difficulties attendant upon laying submarine pipelines between the terminals and shore, across heavily traveled commercial shipping lanes.

The offshore terminal alternative was discarded in this study in favor of more conventional concepts, favoring centralized supertanker terminals within the two major port complexes -- San Francisco Bay and Los Angeles-Long Beach harbors. A future tanker with a loaded draft of 70 feet was assumed as the design vessel. These central terminals would cost less than dispersed terminals within the ports and, in light of present knowledge, are judged a more conservative proposal than offshore terminals.

RECREATIONAL NAVIGATION

In developing a plan to meet future needs, one alternative considered was that no facilities should be developed other than those included in on-going programs. This alternative was rejected for the following reasons. Recreation derived from boating on navigable waters is estimated at one-quarter of all boating recreation in the Region. Recreational studies made in the past have indicated that boating recreation is increasing at a greater rate than any other form of outdoor recreation, and is likely to increase at a sustained high rate in the future. A tenfold increase in the demand for that sector of boating recreation occurring on navigable waters is projected during the study period. Satisfaction of the projected demand was deemed desirable in the interest of promoting physical and mental health through providing a variety of opportunities for outdoor recreation.

Another alternative considered was that projected demand for recreational facilities on navigable waters should be fully met. For the reasons discussed in the preceding paragraph, this alternative was initially accepted. Preliminary investigations indicated that it would be possible to satisfy the demand for coastal harbors, however, the high demand in the South Coastal subregion raised serious questions concerning environmental impacts. A decision was made to constrain allocation of resource use for recreational harbors in the South Coastal subregion, and an alternative means of partially meeting the demand through dry-storage facilities was developed. Full satisfaction of demand was judged feasible in the other coastal subregions without significantly undesirable environmental consequences. However, further studies of environmental impacts at specific selected sites would obviously be needed.

Facilities on inland navigable waters have traditionally been provided largely through private investment. The nature and cost of the facilities has rarely required investment of public funds. Although private supply typically lags somewhat behind demand, it was felt that this system was adequately responsive even though the demand would not be fully met.

Alternatives were then considered in the selection of sites for coastal harbors. Estuaries, lagoons and coastal marshes can be dredged to create small craft harbors at a cost of about half that of constructing offshore harbors. Because of the scarcity of estuaries and wetlands, their importance to marine ecology, and public concern over environmental factors, it was decided that offshore harbors should be emphasized. In some instances, it was judged that harbor development within estuaries or embayments could be accomplished without significant negative impacts; however, in general, estuaries and coastal wetlands were avoided as harbor sites.

Berths to meet future needs could be provided by: (1) phased development of berthing spaces in presently available protected waters of facilities existing in 1965; (2) phased development of berthing spaces in protected waters to be created in small-craft projects and facilities definitely programmed (1965) for completion by 1980; and (3) phased development of berthing spaces in protected waters of small-craft facilities which are not as yet programmed. Launching lanes and transient moorings could be provided within existing and future protected water areas.

The proposed means to satisfy future needs for recreational navigation would include construction of new multi-purpose harbors within which berthing, launching and transient facilities would be provided; expansion of existing multi-purpose harbors; construction of single-purpose harbors of refuge; and development of additional facilities for recreational boats in protected areas of existing navigable waters. About 1,800 acres of protected water area were used for small-craft berthing in 1965. It is estimated that a total of about 2,700 acres of protected water area would be required for berthing in the year 1980; 5,200 acres in the year 2000; and 7,500 acres in the year 2020. Additional protected water area would be required for entrance channels, navigation channels, turning basins and anchorage areas.

Construction of a minimum of 13 new harbors of refuge on the mainland coast and of at least 3 harbors of refuge in the channel islands would also be required. These harbors of refuge could be supplemented by additional improvements to provide destination facilities. The means to satisfy future needs would be met through providing facilities summarized in Table 4. Specific elements of the plan are discussed in the subregional sections of this appendix.

Implementation

GENERAL

This study has attempted to identify needs, and to develop a plan that would satisfy these future needs. This plan would consist of expanding existing navigation facilities and developing additional facilities.

Features included in the quantity and cost estimates include navigation features and non-revenue producing features essential to navigation. "Navigation features" include the following: (1) Protective works, comprising breakwaters and jetties; (2) navigation channels, comprising approach, entrance and interior channels; (3) turning basins, anchorage areas, and maneuvering areas; (4) training walls; (5) levees; and (6) aid to navigation. "Non-revenue producing features" include the following: (1) Access channels and fairways; (2) berthing areas; (3) land development, through fill, or land acquisition; (4) retention or protective

works around the perimeters of the harbors, comprising dikes, bulkheads, and revetments; and (5) public recreational facilities, comprising transient moorings and launching ramps.

CONSTRUCTION AND MAINTENANCE QUANTITIES

Estimated construction quantities for navigation features required in each time frame are summarized in the following table:

Item		Navigation Features Existing 1965	1966-1980	1981-2000	2001-2020
Commercial navigation					
Breakwaters and jetties	(Miles)	14.1	0.3[a]	0.2	0.4
Levees	(Miles)	13.3	7	28	0
Dredging	(Million cu. yds.)	N.A.	136.6	193.9	118.0
Recreational navigation					
Breakwaters and jetties	(Miles)	7.4	6.4	13.4	20.3
Dredging	(Million cu. yds.)	N.A.	5.9	6.8	15.0

(a) Includes 0.2 mile of breakwater removal.

Dredging of non-revenue producing features essential to navigation (including dredging for borrow with which to construct required land) required in each time frame is as follows:

Commercial navigation

1966-1980 82.8 million cubic yards

1981-2000 42.9 million cubic yards

2001-2020 27.1 million cubic yards

Recreational navigation

1966-1980 15.9 million cubic yards

1981-2000 62.8 million cubic yards

2001-2020 150.8 million cubic yards

The average annual quantity of maintenance dredging for the last year of each time frame is given below. The year 1965 is included for the purpose of comparison.

	Millions of cubic yards			
	1965	1980	2000	2020
Federal	8.0	9.1	12.0	15.2
Non-Federal	0.4	2.0	2.6	3.6
Total	8.4	11.1	14.6	18.8

Quantities of annual sand-bypassing at harbor entrances, where the primary purpose is shore protection or beach nourishment, have not been included.

COSTS

Bases for Cost Estimates

The estimated costs of providing and maintaining the required facilities were based on historic cost trends, costs for typical existing facilities, average unit costs for dredging and breakwater construction, and existing preliminary cost estimates adjusted to 1965 price levels.

The costs of revenue-producing features in both commercial and recreational facilities were expressly excluded. These excluded features comprise piers, wharves, cargo storage and transfer facilities, cargo-handling equipment, service and repair facilities, transportation facilities, and slips for small craft.

Estimated installation costs include all features to be provided after 1965, including both those definitely programmed for construction after 1965 and those projected to meet future requirements. Estimated maintenance costs include cost of maintaining all navigation features and non-revenue producing features in existence in 1965, and additional programmed and projected features.

Bases for Cost Apportionment

Costs were apportioned to Federal and non-Federal interests in accordance with present practices. Estimated costs for future commercial navigation facilities were distributed as follows:

(1) The cost of commercial navigation features in authorized Federal projects would be 100 percent Federal.

(2) The cost of non-revenue producing features would be 100 percent non-Federal.

(3) The cost of operation and maintenance of commercial navigation features would be Federal.

(4) The cost of operation and maintenance of non-revenue producing features would be non-Federal.

Estimated costs for future recreation navigation facilities were distributed as follows:

(1) The cost of recreational navigation features in facilities likely to be constructed as Federal projects would be about 50 percent Federal and 50 percent non-Federal.

(2) The cost of recreational navigation features in facilities likely to be constructed as non-Federal improvements would be non-Federal.

(3) The cost of non-revenue producing features, in both future Federal projects and non-Federal improvements, would be non-Federal.

(4) The cost of operation and maintenance of recreational navigation features in future Federal projects would generally be Federal.

(5) The cost of operation and maintenance of recreational navigation features in future non-Federal improvements, would be non-Federal.

(6) The cost of operation and maintenance of non-revenue producing features would be non-Federal.

Summary of Costs

Estimated future construction and maintenance costs for facilities required for navigation in each time frame are summarized in the following tables:

Summary of construction costs ($ Millions)

Item	1966-1980	1981-2000	2001-2020	Total 1966-2020
Commercial navigation facilities				
North Coastal Subregion	5.1	6.6	14.6	26.3
San Francisco Bay Subregion	102.0	233.0	255.0	590.0
Delta-Central Sierra Subregion	46.8	40.7	32.1	119.6
Sacramento Basin Subregion	0	78.0	0	78.0
San Joaquin Basin Subregion	0	0	0	0
Central Coastal Subregion	0	0	0	0
South Coastal Subregion	211.4	246.0	272.0	729.4
Colorado Desert Subregion	0	0	0	0
TOTAL, Region	365.3	604.3	573.7	1,543.3
(Federal)	(83.3)	(192.3)	(104.0)	(879.6)
(Non-Federal)	(282.0)	(412.0)	(469.7)	(1,163.7)
Recreational navigation facilities				
North Coastal Subregion	3.7	15.7	41.0	60.4
San Francisco Bay Subregion	24.0	50.0	70.0	144.0
Delta-Central Sierra Subregion	8.3	21.0	13.0	42.3
Sacramento Basin Subregion	.2	1.4	1.8	3.4
San Joaquin Basin Subregion	0	.2	.3	.5
Central Coastal Subregion	31.7	36.6	23.5	91.8
South Coastal Subregion	64.2	170.0	200.0	434.2
Colorado Desert Subregion	2.4	6.3	12.2	20.9
TOTAL, Region	134.5	301.2	361.8	797.5
(Federal)	(30.1)	(84.4)	(109.6)	(224.1)
(Non-Federal)	(104.4)	(216.8)	(252.2)	(573.4)
TOTAL, ALL NAVIGATION FACILITIES	499.8	905.5	935.5	2,340.8

Summary of average annual maintenance costs 1/ ($ Millions)

Item	1980	2000	2020
Commercial navigation			
Federal	4.850	7.000	8.100
Non-Federal	2.070	2.870	3.240
Subtotal	6.920	9.870	11.340
Recreational navigation			
Federal	3.156	6.060	7.814
Non-Federal	3.060	5.083	6.186
Subtotal	6.216	11.143	14.000
TOTAL	13.136	21.013	25.340

1/ Maintenance of all facilities existing at end of time frame.

Conclusions

In 1965, the ports of the California Region handled almost 100 million tons of waterborne commerce. By 2020, waterborne commerce in the Region will be about 320 million tons. By 2020, the California Region's two major port complexes -- San Francisco Bay and Los Angeles-Long Beach harbors -- will be required to handle about three and one-half times as much waterborne commerce tonnage as these ports handled in 1965. The Region's other harbors will be required to handle about two and one-half times the tonnage they handled in 1965.

The trend toward larger vessels on both international and intracoastal routes is well established. Some of the deeper-draft vessels serving the Region in 1965 could not enter the major ports fully loaded because of channel depths. In 1965, there were about 190 miles of improved navigation channels: by 2020, the plan set forth in this appendix will result in a total of 280 miles of navigation channels adequate to accommodate projected shipping. Channels up to 80 feet in depth may have to be provided to centralized petroleum terminals in San Francisco Bay and Los Angeles-Long Beach harbors.

Established trends in commercial shipping are toward specialized and rapid cargo-handling methods that greatly reduce the time a ship must remain in port. These methods of handling cargo require greatly enlarged cargo-handling areas for efficient operation. In 1965, there were about 3,600 acres of cargo-handling area in the Region's ports; by 2020, the plan set forth in this appendix will result in a total of about 9,300 acres of cargo handling area.

In 1965, the Region's navigable waters had about 41,000 berths for small craft and needed about 51,000 -- a deficiency of about 10,000 berths. By 2020, about 273,000 berths will be needed. The plan set forth in this appendix would provide 262,000 berths or specialized dry-storage spaces for berthable boats in lieu of berths. The residual un-met need would be about 11,000 berths. About 630 launching lanes were needed in 1965, and the Region had about 760. By 2020, about 4,500 launching lanes would be needed. The plan would satisfy these needs except for a residual un-met need of 55 launching lanes. In 1965, the need for transient moorings was about 9,300; there were about 7,900 transient moorings available in that year -- a deficiency of 1,400. By 2020, about 51,000 transient moorings would be needed. The plan would meet these needs.

The Region's ocean shoreline does not provide harbors of refuge for small craft at the spacing of 35 miles that is considered the maximum spacing to permit safe operation of small craft in coastal waters. Although a complete chain of harbors of refuge along the Region's mainland ocean shoreline and on the Channel Islands has been strongly

recommended since the 1940's, no single-purpose harbors of refuge have been built. Thirteen new mainland and three new island harbors of refuge would be required to provide a complete chain of harbors of refuge along the Region's ocean shoreline.

Harbors constructed along the ocean shoreline can influence the littoral transport equilibrium. Shoaling of harbor channels may result, requiring costly maintenance dredging.

The cost of installing commercial navigation facilities during the study period is about $1,543 million, of which about $380 million would be Federal and about $1,163 million woud be non-Federal. The cost of installing recreational navigation facilities, including harbors of refuge, during the study period is about $797 million, of which about $224 million would be Federal and about $573 million would be non-Federal. The total costs for all navigation facilities during the study period would be about $2,340 million.

Recommendations

Incorporate into a master framework plan for the California Region the measures set forth in this appendix to satisfy requirements for commercial and recreational navigation. The major elements of these measures include (1) deepening and widening channels and basins used for commercial shipping; (2) enlarging cargo-handling areas and providing additional berthing areas in commercial ports; (3) constructing protected water areas for berthing small craft; (4) providing launching lanes and transient moorings for small craft; and (5) constructing a chain of harbors of refuge along the ocean shoreline.

Studies should be made to determine what measures should be taken to implement a chain of harbors of refuge.

More extensive studies and data collection programs on the littoral transport phenomena and regimen should be initiated with a view to better understanding of basic coastal phenomena. These studies should be directed toward identifying means to reduce maintenance dredging requirements.

Studies should be made to investigate alternatives to deepening channels to centralized petroleum terminals in San Francisco Bay and Los Angeles-Long Beach harbors. These studies should include determining if offshore installations could function satisfactorily in the open ocean along the California coast, and should evaluate the consequences of accidental oil spills in confined bays and in the open ocean.

CALIFORNIA REGION

TABLE 1

Summary of Waterborne Commerce,[1/] 1965-2020

Type of Commerce	1965	1980	2000	2020
Foreign Exports				
North Coastal	191	680	780	830
San Francisco Bay	2,904	3,510	5,190	8,080
Delta-Central Sierra	1,997	3,520	3,950	4,090
Central Coastal	0	140	140	140
South Coastal	7,913	17,970	25,080	36,480
Total, Foreign Exports	13,005	25,820	35,140	49,620
Foreign Imports				
North Coastal	0	0	0	0
San Francisco Bay	6,085	24,220	50,080	88,420
Delta-Central Sierra	227	280	400	540
Central Coastal	0	0	0	0
South Coastal	13,549	19,370	31,640	46,870
Total, Foreign Imports	19,861	43,870	82,120	135,830
Coastwise Shipments				
North Coastal	297	420	500	570
San Francisco Bay	8,000	10,420	14,650	20,390
Delta-Central Sierra	81	350	420	480
Central Coastal	6,351	6,950	7,070	7,090
South Coastal	10,431	14,420	19,520	23,450
Total, Coastwise Shipments	25,160	32,560	42,160	51,980
Coastwise Receipts				
North Coastal	505	1,170	1,600	2,250
San Francisco Bay	11,717	15,700	19,610	21,960
Delta-Central Sierra	170	360	490	740
Central Coastal	1,072	1,100	1,110	1,120
South Coastal	8,409	11,590	15,290	19,810
Total, Coastwise Receipts	21,873	29,920	38,100	45,880

See footnotes at end of table. Continued.

CALIFORNIA REGION

TABLE 1

Summary of Waterborne Commerce,[1/] 1965-2020 (Cont.)

Type of Commerce	1965	1980	2000	2020
Internal Shipments				
North Coastal	0	0	0	0
San Francisco Bay	9,006	10,160	13,730	18,360
Delta-Central Sierra	19	170	240	270
Central Coastal	0	0	0	0
South Coastal	0	0	0	0
Total, Internal Shipments	9,025	10,330	13,970	18,630
Internal Receipts				
North Coastal	0	0	0	0
San Francisco Bay	7,738	9,430	13,700	17,240
Delta-Central Sierra	2,360	1,750	2,320	3,970
Central Coastal	0	0	0	0
South Coastal	0	0	0	0
Total, Internal Receipts	10,098	11,180	16,020	21,210
Total Commerce				
North Coastal	993	2,270	2,880	3,650
San Francisco Bay	45,450	73,440	116,960	174,450
Delta-Central Sierra	4,854	6,430	7,820	10,090
Central Coastal	7,423	8,190	8,320	8,350
South Coastal	40,302	63,350	91,530	126,610
Grand Total	99,022	153,680	227,510	323,150

1/ Thousands of short tons.

CALIFORNIA REGION

TABLE 2

Additional Commercial Navigation Facilities Required, by Time Frames (Incremental)

Feature / Subregion[1] and Time Frame	Channels		Basins and anchorage areas			Terminal facilities	
	Deepening and widening existing channels	Dredging new channels	Deepening existing basins and anchorage areas	Dredging new basins and anchorage areas	New breakwaters and jetties	Berths	Cargo-handling areas
	(miles)	(miles)	(acres)	(acres)	(miles)	(no.)	(acres)
North Coastal							
1966-1980	5.6	0	0	40	0.1	2	45
1981-2000	11.0	0	100	55	0.2	3	80
2001-2020	11.0	0	140	35	0.4	4	100
San Francisco Bay							
1966-1980	75.0	16.0	600	620	0	20	800
1981-2000	44.0	13.0	1,220	230	0	22	1,250
2001-2020	60.0	10.0	0	300	0	21	1,150
Delta-Central Sierra							
1966-1980	84.0	3.0	137	100	0	7	90
1981-2000	87.0	0	237	13	0	10	130
2001-2020	(a)	0	0	0	0	6	70
Sacramento Basin							
1966-1980	0	0	0	0	0	0	0
1981-2000	0	19	0	9	0	5	40
2001-2020	0	0	0	0	0	0	0
South Coastal							
1966-1980	24.2	5.5	411	34	0.2[(b)]	3	453
1981-2000	8.3	1.9	55	0	0	14	530
2001-2020	11.7	1.5	365	5	0	28	1,400

1/ No significant commercial facilities are required in the other subregions.

(a) Minor widening of existing channel not reported.

(b) Removal of existing breakwater.

CALIFORNIA REGION

TABLE 3

Recreational Navigation Needs, 1965-2020

Feature and Subregion	1965	1980	2000	2020
Number of berths needed				
North Coastal subregion	1,000	1,300	2,500	5,300
San Francisco Bay subregion	12,000	22,000	42,000	67,000
Delta-Central Sierra subregion	11,300	20,700	35,600	49,300
Sacramento Basin subregion	1,000	1,500	2,750	4,900
San Joaquin subregion	100	290	500	800
Central Coastal subregion	1,720	4,000	10,400	22,000
South Coastal subregion	24,000	47,000	90,000	119,000
Colorado Desert subregion	425	1,000	2,200	4,500
Total, California Region	51,545	97,790	185,950	272,800
Launching lanes needed				
North Coastal subregion	26	36	66	140
San Francisco Bay subregion	200	400	700	1,200
Delta-Central Sierra subregion	70	110	160	225
Sacramento Basin subregion	10	15	24	38
San Joaquin subregion	2	3	5	8
Central Coastal subregion	35	50	85	140
South Coastal subregion	130	270	560	1,020
Colorado Desert subregion	160	340	900	1,700
Total, California Region	633	1,174	2,500	4,471
Transient moorings needed				
North Coastal subregion	700	900	1,600	3,000
San Francisco Bay subregion	5,000	9,000	14,000	23,000
Delta-Central Sierra subregion	0	0	0	0
Sacramento Basin subregion	0	0	0	0
San Joaquin subregion	0	0	0	0
Central Coastal subregion	350	750	2,000	5,000
South Coastal subregion	3,200	6,000	12,000	20,000
Colorado Desert subregion	0	0	0	0
Total, California Region	9,250	16,650	29,600	51,000

CALIFORNIA REGION

TABLE 4

Additional Recreational Navigation Facilities Required, by Time Frames

Facility and subregion	1966-1980	1981-2000	2001-2020	Total, study period
Berths [1]				
North Coastal	300	1,200	2,800	4,300
San Francisco Bay	10,000	20,000	25,000	55,000
Delta-Central Sierra	7,300	13,000	12,000	32,300
Sacramento Basin	200	1,000	1,800	3,000
San Joaquin Basin	0	200	300	500
Central Coastal	2,500	6,400	11,600	20,500
South Coastal:				
Berths	15,400	23,000	24,000	62,400
Dry storage in lieu of berths	14,000	20,000	5,000	39,000
Colorado Desert	575	1,200	2,300	4,075
Total, California Region	50,275	86,000	84,800	221,075
Launching lanes				
North Coastal	10	30	74	114
San Francisco Bay	200	300	500	1,000
Delta-Central Sierra	45	15	70	130
Sacramento Basin	4	0	0	4
San Joaquin Basin	4	1	1	6
Central Coastal	15	35	55	105
South Coastal	70	290	460	820
Colorado Desert	200	560	800	1,560
Total, California Region	548	1,231	1,960	3,739
Transient moorings				
North Coastal	200	700	1,400	2,300
San Francisco Bay	4,000	5,000	9,000	18,000
Delta-Central Sierra	0	0	0	0
Sacramento Basin	0	0	0	0
San Joaquin Basin	0	0	0	0
Central Coastal	550	1,250	3,000	4,800
South Coastal	4,000	6,000	8,000	18,000
Colorado Desert	0	0	0	0
Total, California Region	8,750	12,950	21,400	43,100

1/ Including berths to be provided through self-liquidating improvements not included in cost estimates in this appendix.

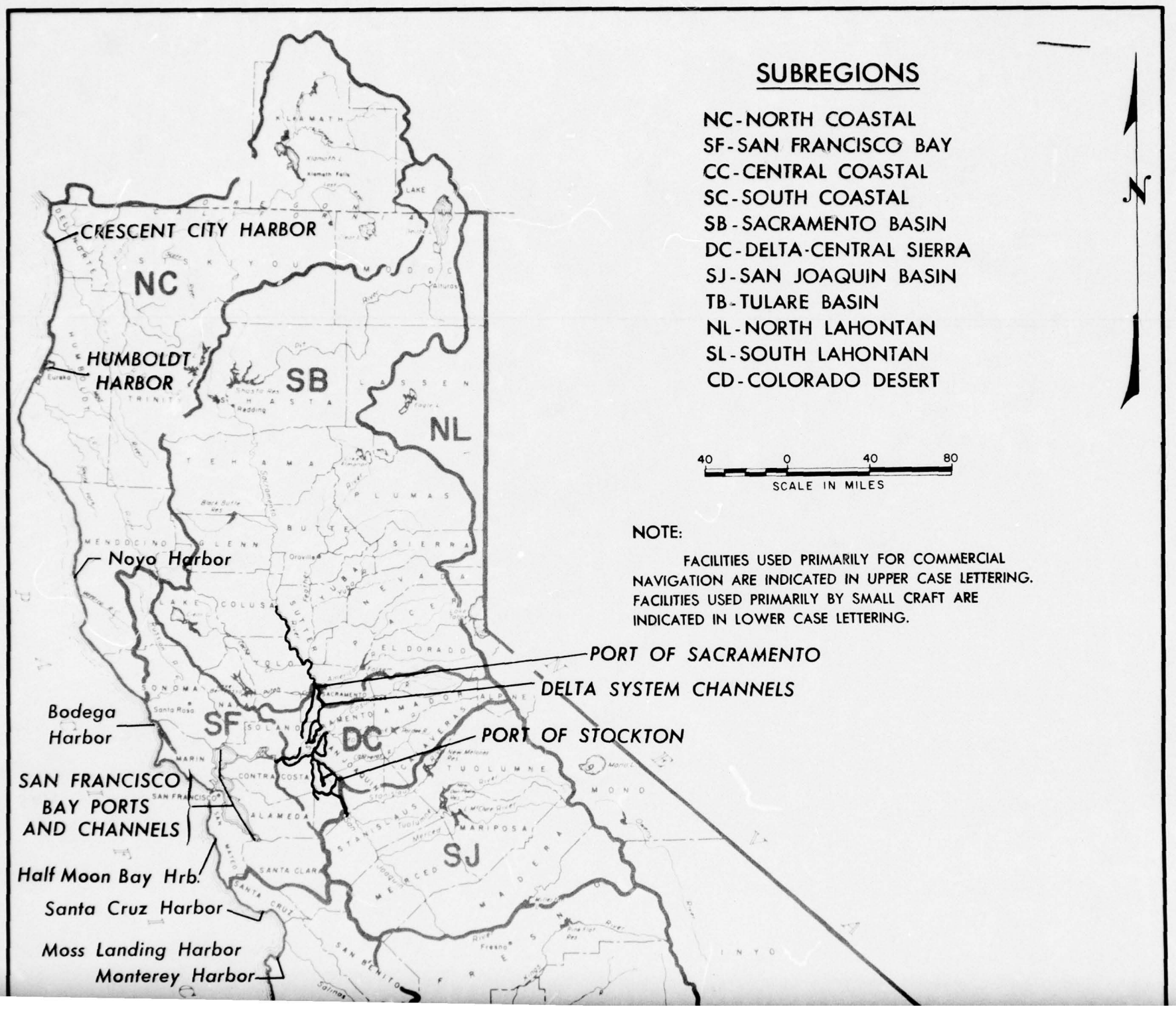
2/ Including 2000 moorings each time frame outside the subregion in Baja California.

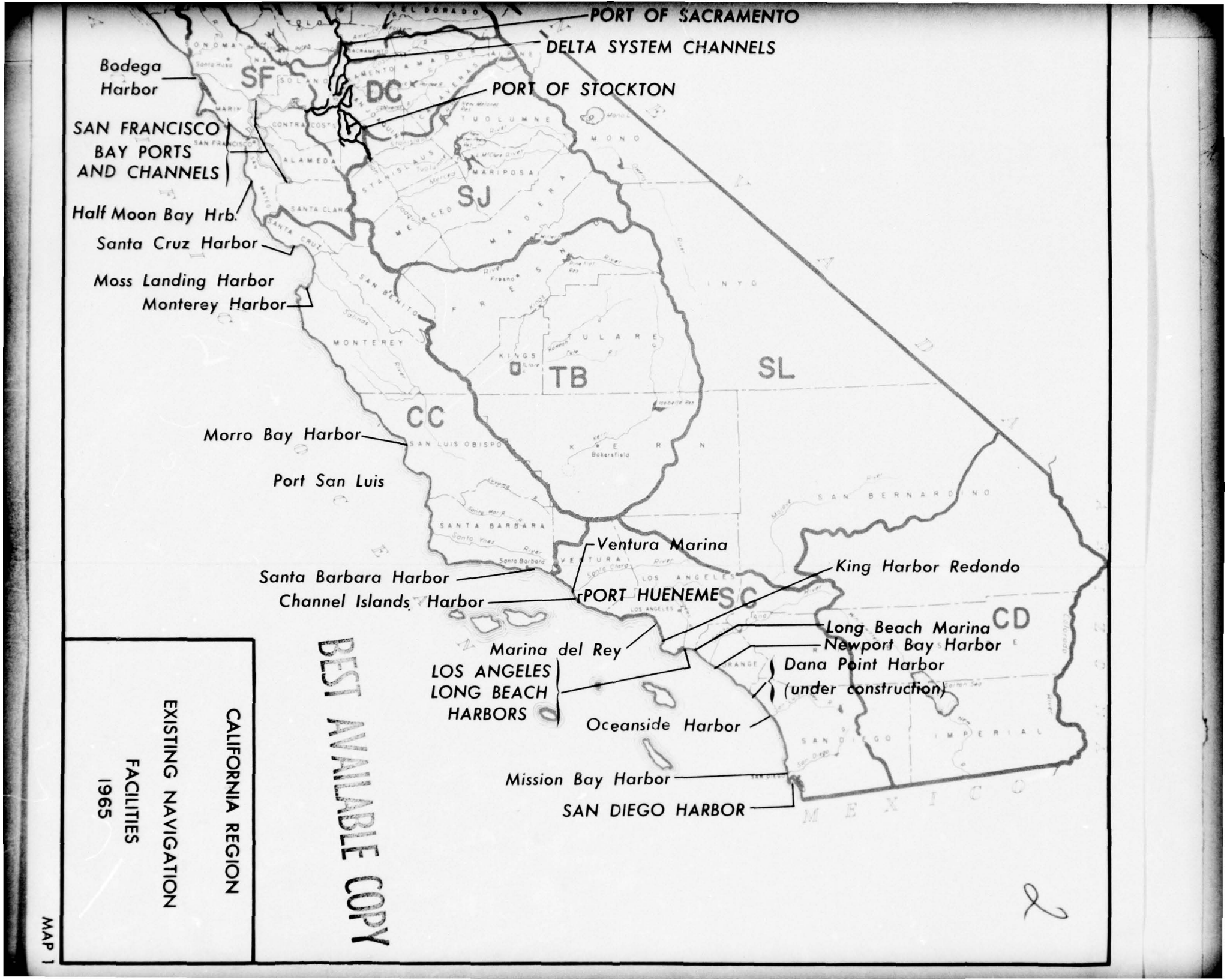
CALIFORNIA REGION
TABLE 5

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	51,545	46,245	97,790	88,160	185,950	86,850	272,800
Needs met:							
Within facilities existing in 1965 1/	41,225	6,785	48,010	700	48,710	0	48,710
Within facilities definitely programmed in 1965	0	12,075	12,075	3,300	15,375	1,500	16,875
Within projected facilities not programmed in 1965	0	31,415	31,415	82,000	113,415	83,300	196,715
Incremental additions		50,275		86,000		84,800	
TOTAL	41,225		91,500		177,500		262,300
Residual un-met needs	10,320		6,290		8,450		10,500
Launching lanes							
Needs	633	601	1,234	1,321	2,555	1,991	4,546
Needs met:							
By lanes existing in 1965	762	0	762	-5 3/	757	-5 3/	752
By projected lanes	0	548	548	1,231	1,779	1,960	3,739
Incremental additions		548		1,226		1,955	
TOTAL	762		1,110		2,536		4,491
Residual un-met needs	0		124		19		55
Transient moorings							
Needs	9,250	7,400	16,650	12,950	29,600	21,400	51,000
Needs met:							
By moorings existing in 1965	7,900	0	7,900	0	7,900	0	7,900
By projected moorings 2/	0	8,750	8,750	12,950	21,700	21,400	43,100
Incremental additions		8,750		12,950		21,400	
TOTAL	7,900		16,650		29,600		51,000
Residual un-met needs	1,350		0		0		0

1/ To be developed through self-liquidating improvements not included in cost estimates.
2/ Including mooring to be developed in Baja California, Mexico.
3/ Through obsolescence of lanes existing in 1965.


SUBREGIONS
NC-NORTH COASTAL
SF-SAN FRANCISCO BAY
CC-CENTRAL COASTAL
SC-SOUTH COASTAL
SB-SACRAMENTO BASIN
DC-DELTA-CENTRAL SIERRA
SJ-SAN JOAQUIN BASIN
TB-TULARE BASIN
NL-NORTH LAHONTAN
SL-SOUTH LAHONTAN
CD-COLORADO DESERT
N
40 0 40 80
SCALE IN MILES
NOTE:
FACILITIES USED PRIMARILY FOR COMMERCIAL NAVIGATION ARE INDICATED IN UPPER CASE LETTERING. FACILITIES USED PRIMARILY BY SMALL CRAFT ARE INDICATED IN LOWER CASE LETTERING.
CRESCENT CITY HARBOR
NC
HUMBOLDT HARBOR
SB
NL
Noyo Harbor
PORT OF SACRAMENTO
DELTA SYSTEM CHANNELS
PORT OF STOCKTON
Bodega Harbor
SF
DC
SAN FRANCISCO BAY PORTS AND CHANNELS
SJ
Half Moon Bay Hrb.
Santa Cruz Harbor
Moss Landing Harbor
Monterey Harbor

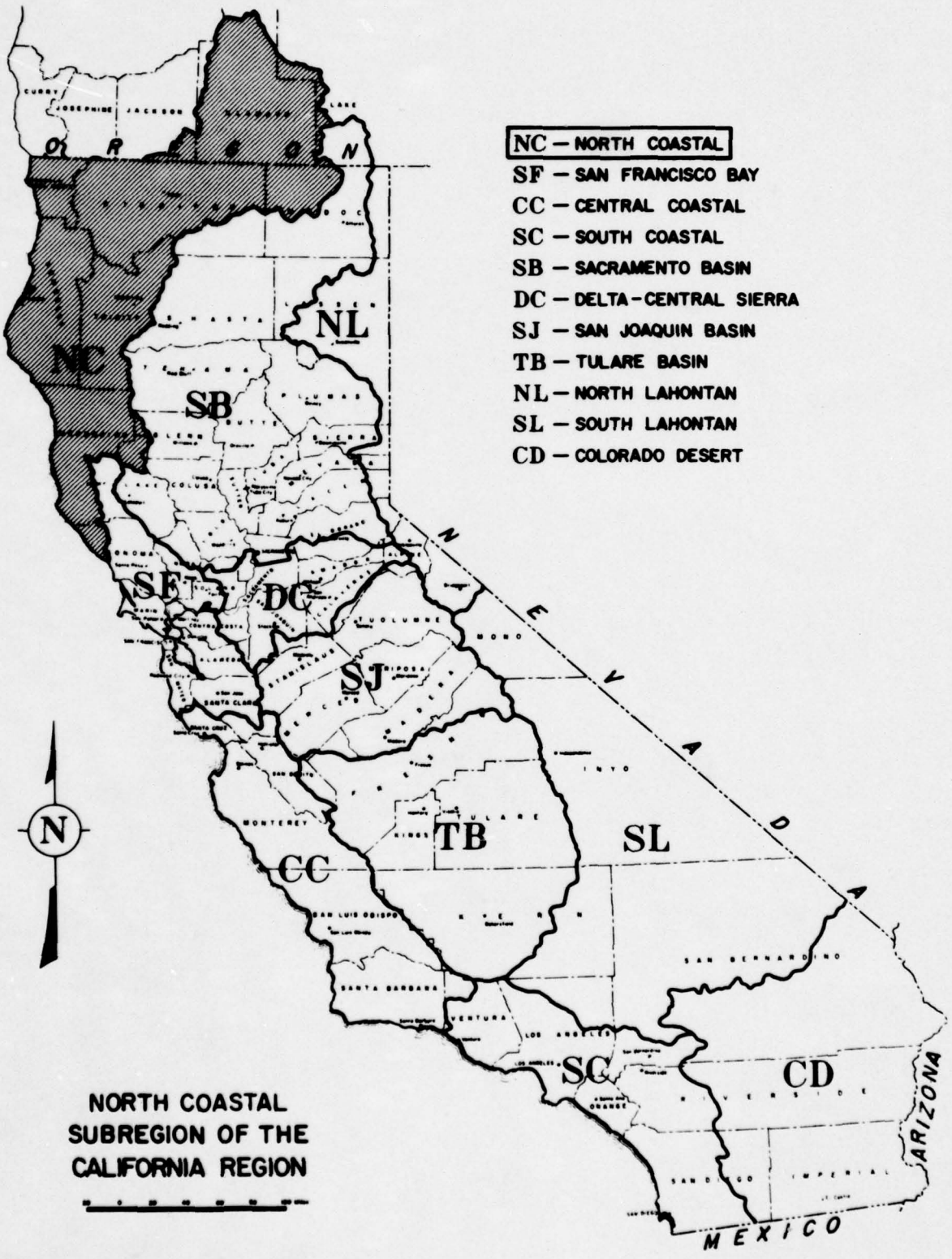


CALIFORNIA REGION

EXISTING NAVIGATION FACILITIES 1965

MAP 1

NORTH COASTAL SUBREGION


NC — NORTH COASTAL
SF — SAN FRANCISCO BAY
CC — CENTRAL COASTAL
SC — SOUTH COASTAL
SB — SACRAMENTO BASIN
DC — DELTA-CENTRAL SIERRA
SJ — SAN JOAQUIN BASIN
TB — TULARE BASIN
NL — NORTH LAHONTAN
SL — SOUTH LAHONTAN
CD — COLORADO DESERT
OREGON
NEVADA
ARIZONA
MEXICO
N
NORTH COASTAL SUBREGION OF THE CALIFORNIA REGION

NORTH COASTAL SUBREGION

General

The North Coastal subregion is located in the northwestern part of the Region and extends along the coast from near the Oregon-California border south to the mouth of the Russian River in Sonoma County. The subregion is described in detail in Appendix II.

The subregion is sparsely settled; only slightly over 1 percent of the Region's total population lived in the subregion in 1965. The economy of the area is shifting through a transitional state of more intensive growth in which the predominance of resource-extractive industries is giving way to a more diversified economic base oriented to external markets. Tourism is expected to become an increasing component of the economy.

During 1965, the waterborne commerce of the North Coastal subregion amounted to nearly 1,000,000 tons, about one percent of the total for the entire California Region. Facilities for commercial navigation are Humboldt Harbor, a deep-draft harbor, and Crescent City Harbor, a shallow-draft harbor situated approximately 72 miles north of Humboldt Harbor. At Humboldt Harbor, an entrance channel 40 feet deep, 26- to 30-foot deep interior channels, and 15 berthing areas are available for deep-draft vessels. The harbor also has a substantial volume of shallow-draft traffic. At Crescent City Harbor, 3 berthing areas and harbor depths of up to 20 feet serve coastwise barge traffic. Waterborne commerce in the subregion consists principally of lumber and petroleum. Harbor locations are shown on Map NC-1. The tributary area for commercial shipping is, for the most part, limited to the North Coastal subregion; however, parts of Coos, Curry, Jackson, Josephine and Lake Counties in Oregon, which lie immediately north of the subregion, fall within the tributary area.

In 1965, about 2,000 recreational small-craft and commercial-fishing vessels were permanently berthed or moored in the subregion's harbors and estuaries. About 5,400 trailered boats made use of coastal and estuarine waters. Berthed boats, for the most part, are owned by residents of the subregion; trailered boats using coastal waters of the subregion include a substantial proportion of boats from the adjacent and more heavily populated subregions, particularly the San Francisco Bay subregion.

Existing Development

GENERAL

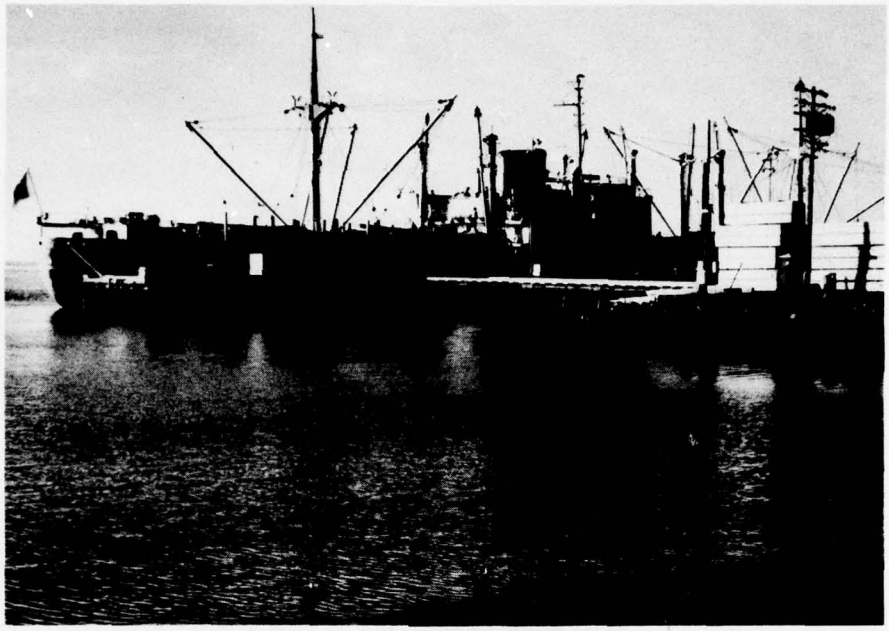
Major subregion navigation activities include transport of petroleum and petroleum products, commercial fishing, and recreational boating. Humboldt Harbor and Crescent City Harbor are the only improved commercial harbors in the North Coastal subregion. Noyo Harbor, approximately 87 miles south of Humboldt Harbor, is the only improved small-craft harbor, but is not an all-weather harbor. Coastal coves and estuaries that are used by small craft for shelter during a part of the year include Fort Ross Cove; Haven's Anchorage, near Gualala Point; the cove near Point Arena; Cuffey Cove, near the Navarro River; Albion Cove; Mendocino Bay; Fort Bragg; Shelter Cove, near Point Delgada; Eel River; Trinidad Harbor; Klamath River and Smith River. Navigation improvements at these sites would be required to provide all-weather protection. Major navigation facilities in the subregion are described in the following paragraphs.

HUMBOLDT HARBOR

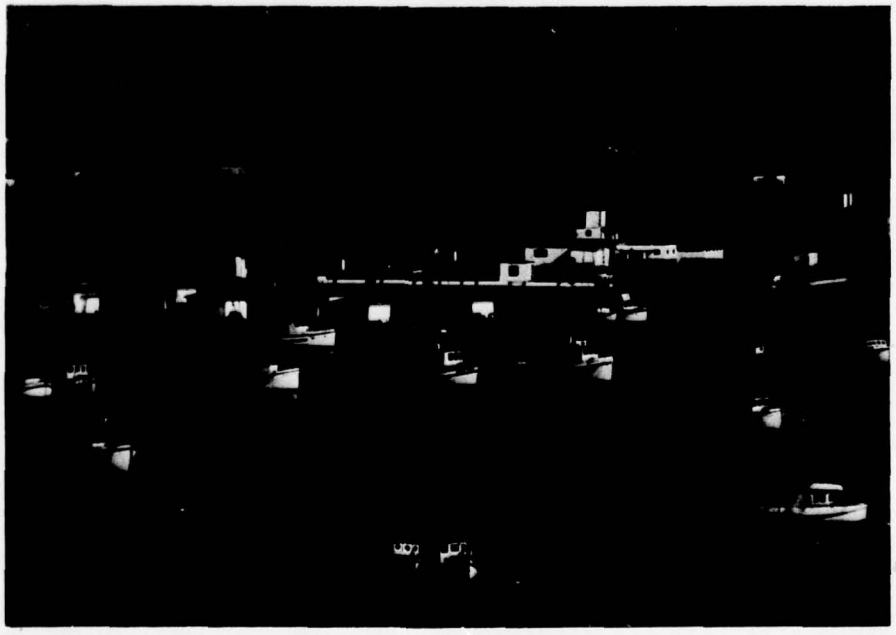
Humboldt Harbor is the largest harbor of the North Coastal subregion, and accounted for about 56 percent of the subregion's waterborne commerce in 1965. The harbor entrance is protected by two rubblemound jetties which were completed in 1891. Dredging of harbor channels was initiated by the Corps of Engineers in 1881. The existing harbor includes a north jetty about 4,500 feet long, and a south jetty about 5,100 feet long. The entrance channel is from 500 to 1,600 feet in width, 40 feet deep and about 1.8 miles long. Interior channels range in width from 300 to 400 feet, in depth from 26 to 30 feet, and comprise 9.2 miles of channel. The one turning basin is 600 feet wide and 800 feet long with a depth of 26 feet. Deepening of existing project channels and dredging of an anchorage area has been authorized by the 1968 River and Harbor Act. About $18,000,000 has been expended by the Federal Government on Humboldt Harbor, comprised of $5,500,000 for construction and $12,500,000 for maintenance.

Waterborne commerce in 1965 was 560,000 tons, of which 191,000 tons were foreign and 369,000 tons were domestic. (See Table NC-1). The leading commodities handled were lumber and petroleum. Vessel traffic was about 400 trips in 1965 (a trip consisting of an inbound and outbound passage). The harbor has 15 berths and about 120 acres of open-storage and cargo-handling area. Physical features are summarized in Table NC-3.

The principal inbound commodities entering Humboldt Harbor are petroleum products, which terminate at Eureka for transshipment to other parts of Humboldt County and as far east as Yreka. The principal outbound commodities are forest products, originating mainly in Humboldt, Del Norte and Trinity Counties. Shipping patterns are not expected to vary substantially during the next half century. (See Table NC-2.) The subregion's rugged topography



Lumber and lumber products are important exports from Humboldt Harbor. This freighter is loading lumber for the Orient.
(Corps of Engineers photo)



The small craft mooring area at Crescent City Harbor.
(Corps of Engineers photo)

and the resultant minimal land-transportation network have constrained port development. With the excention of the coastal plain, extending about 35 miles from the Eel River Delta to Trinidad, the tributary area is generally mountainous with numerous narrow valleys and canyons and is densely forested. Mountain peaks range in elevation from 3,000 to 8,000 feet. A single rail line, the Northwestern Pacific Railroad, traverses the mountain range through the Eel River Valley to the San Francisco Bay area. No direct transcontinental rail service is available. Construction of U.S. Highway 101 through the Eel River Valley to freeway standards is underway. Completion of this coastal freeway will moderate the geographical constraints and more efficiently connect Humboldt Harbor with its potential sources of raw materials and markets for its imports.

In addition to deep-draft vessels, Humboldt Harbor also berths commercial-fishing vessels and recreational small craft. Fish landings averaged about 12,000 tons per annum during the decade ending in 1965. Approximately 450 commercial-fishing vessels register Humboldt Harbor as their home port. Some of these are recreational craft which are licensed for commercial fishing. Berths for about 200 recreational small craft are available within the harbor.

CRESCENT CITY HARBOR

Crescent City Harbor exports lumber products and imports refined petroleum products. Although maximum vessel drafts are limited to about 20 feet by existing project depths, approximately 433,000 tons (about 44 percent) of the waterborne commerce of the North Coastal subregion passed through Crescent City Harbor. Refined petroleum products, transshipped by truck to a relatively large tributary area, account for more than half the annual tonnage. (See Table NC-2) In addition to the northern counties of the subregion, the tributary area of Crescent City Harbor also includes several counties in Oregon lying just north of the North Coastal subregion. Non-self-propelled barges transport refined petroleum products to Crescent City Harbor from refineries in the San Francisco Bay area and from Washington and Oregon. Timber products from Del Norte, Humboldt and Siskiyou Counties in California and Josephine County in Oregon are barged out principally to Southern California ports. Lumber shipments to San Francisco Bay ports and Honolulu, Hawaii, are also substantial.

Existing Federal improvements at Crescent City Harbor include an outer breakwater and realigned breakwater extension approximately 4,700 feet long, an inner breakwater approximately 1,200 feet long, an outer harbor basin 20 feet deep, except in rock, a sand barrier from the shore to Whaler Island, and a fish-boat basin 10 feet deep. Construction was completed in 1957. Extension of the Inner Harbor breakwater and construction of a harbor basin have been authorized by the 1965 River and Harbor Act. About $9,400,000 has been expended by the Federal Government on Crescent City Harbor, comprised of $6,300,000 for construction, and $3,100,000 for maintenance.

Three terminal facilities, including a privately-owned wharf, a publicly-owned and operated dock, and a privately-owned bulk-oil facility operated during 1965. Vessel trips totaled about 300 (inbound and outbound passage). About 15 acres of cargo-handling area, with storage space for 10 to 15 million board feet of lumber, and a 184,000-barrel tank farm are located within one-half mile of the harbor. The tsunami of March 1964 caused extensive damage in the harbor. The Corps of Engineers removed debris and repaired and restored harbor facilities.

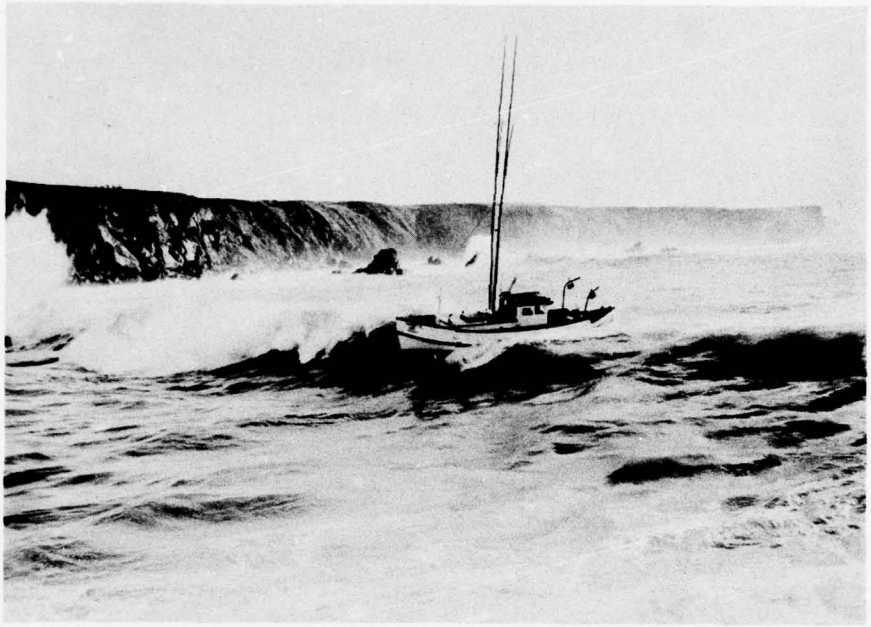
During the peak of the fishing season, about 250 fishing vessels moor at Crescent City Harbor. A permanently-based commercial-fishing fleet of about 100 vessels and one party boat operate from the harbor. Twenty berths for recreational small craft are available at Citizens' Dock. The harbor also has two hoists for launching trailer boats. Commercial-fish landings average about 3,000 tons per annum.

Crescent City Harbor is connected with coastal points to the north and south by U.S. Highway 101. U. S. Highway 199 and other improved highways connect Crescent City Harbor to other parts of the tributary area. No railroad connection exists between Crescent City Harbor and other points in the tributary area, although local interests have attempted to persuade the Southern Pacific Company to extend its lines to Crescent City. Construction of the desired railroad extension would expand the existing tributary area. A local commercial airport provides service to Portland, Oregon, San Francisco, California, and other points to the north and south.

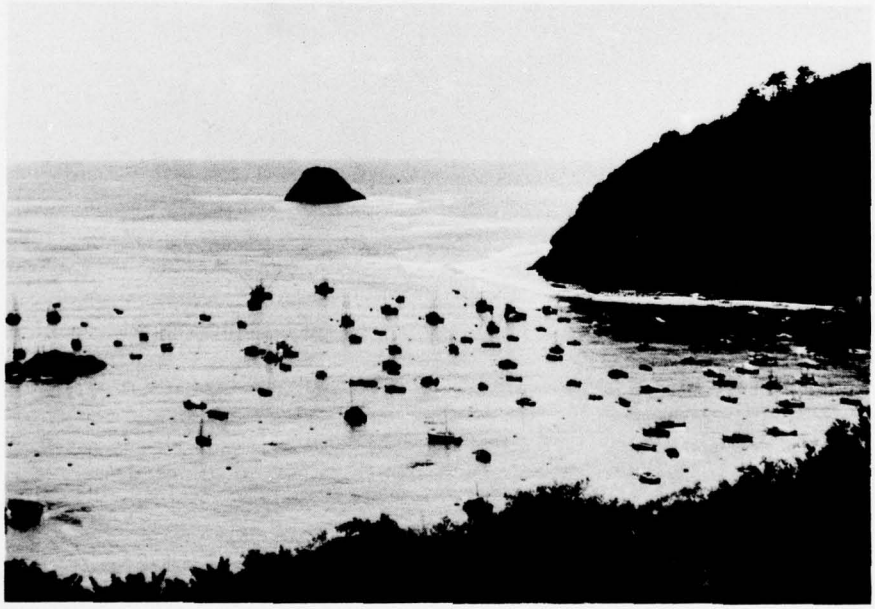
NOYO HARBOR

Waterborne commerce at Noyo Harbor during 1965 amounted to approximately 4,000 tons, mostly fresh fish and shellfish. Existing terminal facilities include fish-receiving wharves, fish-packing plants, and miscellaneous small-craft facilities. Vessel traffic includes commercial-fishing vessels and recreational small craft. During peak periods, the commercial-fishing fleet utilizing the harbor varies from 300 to 600 boats. During the salmon season, recreational craft brought in by sports fishermen may increase the sports fishing fleet to as many as 300 boats. During 1965, berthing facilities were available to accommodate about 50 small craft; however, numerous small craft and commercial fishing vessels would anchor in the lower reaches of the river when weather permitted.

Harbor improvements include an entrance channel 100 feet wide and 10 feet deep protected by north and south jetties and walls extending about 1,000 feet and 240 feet in length, respectively. The River Channel is 150 feet wide and 10 feet deep, and extends upstream about 0.6 mile. Construction of the jetties was authorized by the 1922 River and Harbor Act. The jetties were completed in 1924. Reconstruction of the jetties and excavation of the Entrance and River Channels were authorized by the 1930 River and Harbor Act, and this work was completed in 1931. A connecting channel and



The entrance to Noyo Harbor is extremely hazardous during storm periods or when there are heavy swells. The salmon fishing fleet had been at sea when these swells built up catching the fleet unawares. (Photo furnished by courtesy of Tony Tarantino, of the Frank Alioto Fish Co. Fort Bragg)



Trinidad Anchorage affords fair-weather shelter to small craft and is heavily used during the fishing season. This site has been suggested for a future all-weather harbor of refuge.
(Corps of Engineers photo)

mooring basin about one mile upstream from the jetties were completed by the Noyo Harbor District in late 1968 with funds provided by an Economic Development Administration grant and a State of California loan. The mooring basin provides about 265 berthing spaces for commercial-fishing boats and recreational boating.

RECREATIONAL NAVIGATION

In 1965, about 2,000 small craft were permanently berthed or moored in harbors, coves, and estuaries in the North Coastal subregion. Distribution of small-craft berthing facilities by counties is shown in Table NC-4.

Trailered-boat facilities are located at nearly all small-craft installations in the North Coastal subregion. About 26 launching ramps were in service during 1965, the base year. Of the total, about half were surfaced with concrete or other lining, and half were un-surfaced. In addition, about one-fourth of the installations operated boat hoists of comparable boat-launching capability in lieu of, or in conjunction with boat launching ramps.

No Federal expenditures for small-craft navigation improvements have been made through 1 July 1965 in the North Coastal subregion. However, improvements constructed by the Corps of Engineers at Crescent City Harbor and Humboldt Harbor enable these facilities to serve as harbors of refuge for recreational and commercial small craft; and the Federal expenditure of $325,000 for the rebuilding of facilities at Crescent City Harbor after the destructive tsunami of March 1964 was of direct benefit to recreational small craft and commercial-fishing boats using the harbor.

Existing berthing and mooring facilities are adequate in number to satisfy current demand. Improvements are required at existing berthing areas to improve entrance conditions, provide additional protection from wave action, provide additional or modernized supporting shore facilities and/or to eliminate rock and shoals.

Future Needs

COMMERCIAL NAVIGATION

General

The future needs for commercial navigation were assessed in terms of projected waterborne commerce tonnages considered in terms of commodity classes. The bases for the projections are discussed in the following paragraphs.

Tributary areas

Tributary areas for Crescent City Harbor and Humboldt Harbor were delineated in detail during studies made by the Corps of Engineers, published as parts of House Documents 264 and 330, 89th Congress, 1st session, and 90th Congress, 2d session, respectively.

Traffic and Commodities

The Project (House) Document projections for lumber shipments at Crescent City Harbor were used in this report without adjustment. Petroleum receipts were adjusted to reflect actual tonnages recorded for 1965, the base year, and were further adjusted to Base Plan population projections for the tributary area. The Project Document estimates for Humboldt Harbor were increased to allow for the receipt of wood chips to supplement the local supply. Current information from local industries indicates that locally-produced supplies of wood chips are inadequate to meet requirements. See Tables NC-1 and NC-2 for projections of waterborne commerce in the North Coastal subregion.

RECREATIONAL NAVIGATION

General

Projections of future boat ownership were based on the methodology used in the "California Small-Craft Harbors and Facilities Plan, Comprehensive Report," dated March 1964, prepared for the State of California adjusted to reflect subsequently available data. The future needs for recreational navigation were assessed in terms of permanent berthing facilities, launching facilities, and transient and destination facilities. These needs are discussed in the following paragraphs and are summarized in Table NC-4.

Berthing Facilities

Present and projected needs for berthing facilities were based upon evaluation of the positive effects of increased disposable income on berthable boat ownership and the negative effects of congestion. Congestion would not have a measurable effect in the North Coastal subregion. The theoretical ratio of berthable boats to population was estimated at 4.5 berthable boats per thousand population in 1965, 5.0 in 1980, 5.5 in 2000, and 6.0 in 2020. Applying the computed ratios to population projections for the subregion resulted in a theoretical demand for berths for about 5,300 boats by the year 2020.

Trailered-boat Facilities

The present and projected needs for trailered-boat facilities were based upon the estimated use of ocean waters as presented in the "Comprehensive Report" and modified as previously stated. Tourists from adjacent

subregions are served by trailered-boat facilities in the North Coastal subregion. Estimated requirements for launching facilities to meet current and projected demands are given on Table NC-4.

Transient and Destination Facilities

Although used as a harbor of refuge, entrance conditions at Humbolt Harbor are hazardous to small boats during moderately heavy seas or swells. Noyo Cove is subject to heavy wave action from the southwest through the northwest, and, during periods of heavy seas, the jettied entrance to the river channel is impassable either for entry or departure. Crescent City Harbor is considered adequate as a harbor of refuge for small craft. Construction of the authorized 300-foot extension to the Inner Breakwater would reduce inner harbor wave heights during periods of adverse weather and heavy seas.

A Corps of Engineers report published in 1949 on harbors for light-draft vessels along the northern California coast recognized the need for a chain of harbors of refuge. In January 1963, the State of California, Department of Parks and Recreation published an interim report on coastal harbors of refuge. Both reports stress the urgent necessity for construction of harbors of refuge at 30 to 35-mile intervals to assure safety of small craft cruising along the coastal shoreline. This distance is based on considerations of how far a small vessell can travel after receipt of weather warnings, and under worsening weather conditions, to reach refuge. The 230 nautical miles between the south boundary of the subregion and Crescent City Harbor is extremely hazardous for navigation by small vessels.

Intracoastal cruising by recreational vessels is presently severely constrained by the lack of a chain of harbors of refuge in the subregion. Additional harbors of refuge would be required to provide increased safety for ocean boaters by minimizing the risk to life and property from sea and weather hazards and from accidents. These harbors would also enhance recreational opportunities by providing new boating destinations, encouraging cruising, opening presently under-exploited fishing grounds to recreational fishing, and making additional ocean reaches and coastal segments accessible to the public.

Each all-weather harbor of refuge would require the following facilities: (1) an entrance that can be navigated at all but the most extreme periods of the worst storms; (2) appropriate navigation aids; (3) a public landing; (4) a protected anchorage area for transient vessels; (5) land access; (6) communications facilities; (7) fuel for transient boats; (8) a potable water supply; and (9) sanitary facilities. The estimated peak-period overnight transient use is summarized in Table NC-5.

Means To Satisfy Future Needs

COMMERCIAL NAVIGATION

General

The means to satisfy future needs for commercial navigation in the North Coastal subregion would consist primarily of expanding existing commercial harbor facilities at Humboldt Harbor and Crescent City Harbor. The needs of commercial-fishing vessels can be met by the planned commercial harbors and the proposed chain of harbors of refuge and by upgrading of existing terminal facilities. Projected navigation features are given in terms of controlling dimensions, and are based on the assumption that vessel-waiting time for favorable tides would be eliminated. Projected characteristics of the largest vessels expected to call at the subregion's port and terminal facilities are based on the assumptions that conventional monohull ships will continue to serve most of the needs of waterborne commerce and that present trends towards larger vessels will continue. Projected terminal-facility characteristics are based on the assumption that present trends toward sophisticated cargo-handling techniques will continue. Cargo classifications include liquid bulk, dry bulk, break-bulk cargo, and also unitized or containerized cargos. The future needs at the three programmed commercial harbors are discussed in the following paragraphs.

Humboldt Harbor

A Federal plan for the improvement of Humboldt Harbor is contained in House Document 330, 90th Congress, 2d session. This plan provides for deepening and widening of existing navigation channels and dredging of an anchorage area. It is anticipated that additional channel deepening will be required to meet petroleum supertanker and commercial shipping requirements by the year 2020. The authorized plan and subsequent improvements necessary to meet the needs for navigation are discussed in the following subparagraphs.

Authorized Navigation Features

The authorized plan provides for the following navigation features: (1) a south jetty about 5,100 feet long, and a north jetty about 4,500 feet long; (2) an entrance channel 40 feet deep, 500 to 1,600 feet wide and about 1.8 miles long; (3) a north bay channel 35 feet deep, 400 feet wide and 3.4 miles long; (4) Samoa channel 35 feet deep, 300 feet wide and about 1.5 miles long; (5) Eureka channel 26 to 35 feet deep, 400 feet wide and about 2.0 miles long; (6) Fields Landing channel 26 feet deep, 300 feet wide and about 2.3 miles long, terminating in a turning basin 26 feet deep, 600 feet wide and 800 feet long; and (7) an anchorage area 35 feet deep, 1,200 feet wide and 1,200 feet long. In order to accommodate

deeper draft vessels in the future, it will be necessary to further deepen the entrance channel to 45 feet by the year 2000, and 50 feet by the year 2020. Corresponding deepening of the inner harbor channels will be required. See Table NC-3 for projected dimensions of navigation features.

Terminal Facilities

The number of berths will increase from 15 to 18 during the next half century, and cargo-handling area will increase from 120 acres to 300 acres. One of the berths will probably be adapted to the handling of containerized commercial shipping.

Crescent City Harbor

A Federal plan for the improvement of Crescent City Harbor is contained in House Document 264, 89th Congress, 1st session. This plan provides for a 300-foot extension of the Inner Breakwater and a T-shaped basin 20 feet deep, about 1,500 feet long with a stem 1,000 feet long. The existing project includes an outer breakwater 4,700 feet long, an inner breakwater extending northwesterly from Whaler Island about 1,200 feet long, a sand barrier from the shore to Whaler Island, an Outer Harbor Basin 20 feet deep, and a fish-boat basin 10 feet deep. It is expected that harbor depths will be progressively increased from 20 feet to 35 feet during the next half century, and that berths will increase in number from 4 to 10, and cargo-handling area will increase from 15 to 60 acres. See Table NC-3 for projected data on navigation features and terminal facilities.

Commercial Fishing Facilities

Terminal facilities for fresh fish are located at Crescent City Harbor, Humboldt Harbor, Noyo Harbor, Albion Cove, and Trinidad Harbor in the North Coastal subregion. About 1,000 boats of the California Region's fishing fleet are permanently berthed in the subregion. A comparable number of commercial fishing vessels using facilities in the North Coastal subregion are based in Oregon and Washington and the more southerly subregions of the California Region. Additional terminal facilities would be provided in some of the additional harbors of refuge recommended for construction.

RECREATIONAL NAVIGATION

Recreational boating and commercial fishing are closely related activities in the North Coastal subregion. Many recreational small boats are licensed as commercial-fishing craft, and operate as commercial-fishing vessels from time to time. Others obtain commercial-fishing licenses to avoid restrictions on fish catch which are imposed upon sports fishermen. Facilities for both recreational boats and commercial-fishing vessels

would be included in the projected harbors of refuge for light-draft vessels. Since the number of sports fishing and recreational small craft has been increasing rapidly, and the number of commercial-fishing vessels is tending to stabilize at the present level, the recommended plan is primarily oriented to accommodation of recreational small craft.

As indicated in Table NC-4, by the year 2020 there will be a requirement for 5,300 berths, 3,000 transient mooring facilities, and 140 launching ramps for recreational boating in the North Coastal subregion. Some possible sites for future harbors are shown on Map NC-2. Some of the sites may involve environmental problems, or difficult construction problems. Detailed studies would be required before future harbor sites can be definitely selected. About 10 harbors will probably be required to meet the subregion's future needs. In addition to serving as harbors of refuge, each harbor would be required to provide approximately 400 berths, 300 moorings and 14 launching lanes, on the average. As indicated in Table NC-4, Federal projects along the coast would provide berths for about 4,100 recreational craft, and accommodations for approximately 1,200 boats would be provided in private facilities located in the lower reaches of coastal streams. The Federal projects would include harbors with design capacities ranging from 100 to 1,000 berths, depending upon local demand factors and site conditions. Boat launching lanes and mooring facilities would be distributed proportionately to meet demands. The plan to meet needs for recreational navigation is summarized in Table NC-6.

Implementation

Implementation of the navigation plan for the North Coastal subregion would require construction of about 6 miles of protective breakwaters and jetties, and dredging of about 27,000,000 cubic yards during the study period. Four-fifths of the dredging would be required for the Federal projects and one-fifth of the dredging would be required for non-Federal improvements. Estimated quantities by period are as follows:

Item	Unit	1966-1980	1981-2000	2001-2020
Commercial navigation				
Breakwaters and jetties	Lin.ft.	300	1,000	2,000
Dredging				
Federal	Cu. yds.	4,000,000	7,500,000	8,000,000
Non-Federal	Cu. yds	1,000,000	1,500,000	1,500,000
Recreational navigation				
Breakwaters and jetties	Lin.ft.	1,500	8,000	18,000
Dredging				
Federal	Cu. yds.	200,000	600,000	1,000,000
Non-Federal	Cu. yds.	500,000	600,000	900,000

Estimated average annual maintenance dredging quantities are as follows:

Item	Unit	1980	2000	2020
Commercial navigation				
Federal	Cu. yds.	750,000	1,400,000	2,000,000
Non-Federal	Cu. yds.	250,000	450,000	550,000
Recreational navigation				
Federal	Cu. yds.	40,000	50,000	60,000
Non-Federal	Cu. yds.	26,000	31,000	37,000

Estimates of first costs and costs of maintenance, operation and replacement of projected improvements were based upon currently available data adjusted to 1965 price levels. Bases for cost estimates and cost allocations are set forth in the regional summary. Total construction costs for the projected navigation improvements would amount to approximately $86 million during the study period. Commercial navigation features would involve expenditures of about $26 million and recreational navigation would amount to $60 million. The Federal investment would amount to about $53 million, including $24 million for commercial navigation and $29 million for recreational navigation. The non-Federal costs would be about $1.8 million for commercial navigation, including costs for land acquisition and development and cargo-handling areas, and about $31.4 million for recreational navigation. Estimated costs by time period are as follows:

Summary of first costs

Feature	1966-1980	1981-2000	2001-2020
Commercial navigation			
Federal	$4,500,000	$6,000,000	$14,000,000
Non-Federal	600,000	600,000	600,000
Recreation navigation			
Federal	1,500,000	7,500,000	20,000,000
Non-Federal	2,200,000	8,200,000	21,000,000

Summary of annual maintenance costs

Feature	1980	2000	2020
Commercial navigation			
Federal	$800,000	$850,000	$900,000
Non-Federal	70,000	170,000	240,000
Recreational navigation			
Federal	56,000	160,000	314,000
Non-Federal	10,000	13,000	16,000

NORTH COASTAL SUBREGION

TABLE NC-1

Summary of Waterborne Commerce[1/], 1965-2020

Type of Commerce	1965[2/]	1980	2000	2020
Foreign Exports				
Humboldt Harbor	191	680	780	830
Crescent City Harbor	0	0	0	0
Total, Foreign exports	191	680	780	830
Foreign Imports				
Humboldt Harbor	0	0	0	0
Crescent City Harbor	0	0	0	0
Total, Foreign imports	0	0	0	0
Coastwise Shipments				
Humboldt Harbor	120	210	250	270
Crescent City Harbor	177	210	250	300
Total, Coastwise shipments	297	420	500	570
Coastwise Receipts				
Humboldt Harbor	249	790	1,010	1,330
Crescent City Harbor	256	380	590	920
Total, Coastwise receipts	505	1,170	1,600	2,250
Total Commerce[3/]				
Humboldt Harbor	560	1,680	2,040	2,430
Crescent City Harbor	433	590	840	1,220
Grand Total, Subregion	993	2,270	2,880	3,650

1/ Thousands of short tons.
2/ From Waterborne Commerce of the United States, Part 4, Department of the Army, Corps of Engineers.
3/ Local and internal traffic is not significant at these ports.

NORTH COASTAL SUBREGION

TABLE NC-2

1965 Waterborne Commerce[1/], by Commodities, and Projected Waterborne Commerce 1980-2020

Commodity Group	1965[2/]	1980	2000	2020
HUMBOLDT HARBOR				
Foreign Exports				
Lumber products	186	320	380	400
Wood pulp	5	360	400	430
Miscellaneous	0	0	0	0
Subtotal, exports	191	680	780	830
Foreign Imports				
Shellfish	0	0	0	0
Miscellaneous	0	0	0	0
Subtotal, imports	0	0	0	0
Total, Foreign commerce	191	680	780	830
Coastwise Shipments				
Lumber products	119	68	93	100
Wood pulp	0	140	154	166
Miscellaneous	1	2	3	4
Subtotal, shipments	120	210	250	270
Coastwise Receipts				
Petroleum	234	350	550	850
Wood manufactures	0	350	350	350
Chemicals	7	80	90	100
Miscellaneous	8	10	20	30
Subtotal, receipts	249	790	1,010	1,330
Total, Coastwise commerce	369	1,000	1,260	1,600
TOTAL ALL TRAFFIC HUMBOLDT HARBOR [3/]	560	1,680	2,040	2,430

See footnotes at end of table.

Continued.

NORTH COASTAL SUBREGION

TABLE NC-2

1965 Waterborne Commerce[1], by Commodities, and Projected Waterborne Commerce 1980-2020 (Cont.)

Commodity Group	1965[2]	1980	2000	2020
CRESCENT CITY HARBOR				
Coastwise Shipments				
Log and lumber products	177	210	250	300
Miscellaneous	0	0	0	0
Subtotal, shipments	177	210	250	300
Coastwise Receipts				
Petroleum	256	380	590	920
Miscellaneous	0	0	0	0
Subtotal, receipts	256	380	590	920
Total, Coastwise commerce	433	590	840	1,220
TOTAL ALL TRAFFIC, CRESCENT CITY HARBOR [3]	433	590	840	1,220

1/ Thousands of short tons.
2/ From Waterborne Commerce of the United States, Part 4, Department of the Army, Corps of Engineers.
3/ Local and internal traffic is not significant at this port.

NORTH COASTAL SUBREGION

TABLE NC-3

Existing and Projected Commercial Navigation Features and Terminal Facilities

	1965	1980	2000	2020
HUMBOLDT HARBOR AND BAY				
Navigation features:				
Jetties:				
Length, miles	1.9	1.9	1.9	1.9
Entrance channel:				
Depth, feet	40	40	45	50
Length, miles	1.8	1.8	1.8	1.8
North Bay channels:				
Depth, feet	30	35	40	45
Length, miles	5.6	5.6	5.6	5.6
Inner Eureka channel:				
Depth, feet	26	26	30	35
Length, miles	1.3	1.3	1.3	1.3
Fields Landing channel:				
Depth, feet	26	26	30	35
Length, miles	2.3	2.3	2.3	2.3
Turning basin:				
Depth, feet	26	26	30	35
Area, acres	10	10	25	40
Anchorage area:				
Depth, feet	—	35	40	45
Area, acres	—	30	40	50
Terminal facilities:				
Berths, number	15	16	17	18
Cargo-handling area, acres	120	160	220	300

Continued.

NORTH COASTAL SUBREGION

TABLE NC-3

Existing and Projected Commercial Navigation Features and Terminal Facilities (Cont.)

	1965	1980	2000	2020
CRESCENT CITY HARBOR				
Navigation features:				
Breakwaters, miles	1.1	1.2	1.4	1.8
Sand barrier, miles	0.2	0.2	0.2	0.2
Harbor basins				
Depth, feet	10-20	10-20	20-25	20-35
Area, acres	60	70	100	110
Terminal facilities:				
Berths, number	4	5	7	10
Cargo-handling area, acres	15	20	40	60

NORTH COASTAL SUBREGION

TABLE NC-4

Berthing Capacity of Existing, Programmed and Projected Facilities, 1965-2020

	Berthing Capacity			
	1965	1980	2000	2020
1. EXISTING FACILITIES (1965)				
Federal projects				
Del Norte County	20			
Subtotal, Federal	20			
Non-Federal improvements				
Del Norte County	400			
Humboldt County	430			
Mendocino County	150			
Subtotal, non-Federal	980			
TOTAL, EXISTING FACILITIES	1,000	1,000	1,000	1,000
2. PROGRAMMED FOR CONSTRUCTION (1965)				
Federal projects				
Humboldt County		130		
Subtotal, Federal		130		
Non-Federal improvements				
Del Norte County		10		
Humboldt County		10		
Mendocino County		150		
Subtotal, non-Federal		170		
TOTAL, PROGRAMMED FOR CONSTRUCTION		300	300	300

Continued.

NORTH COASTAL SUBREGION

TABLE NC-4

Berthing Capacity of Existing, Programmed and Projected Facilities, 1965-2020 (Cont.)

	Berthing Capacity			
	1965	1980	2000	2020
3. PROJECTED FACILITIES, NOT PROGRAMMED				
Federal projects				
Del Norte County			200	500
Humboldt County			400	1,500
Mendocino County			300	1,000
Subtotal, Federal			900	3,000
Non-Federal improvements				
Del Norte County			50	250
Humboldt County			150	350
Mendocino County			100	400
Subtotal, non-Federal			300	1,000
TOTAL PROJECTED FACILITIES NOT PROGRAMMED			1,200	4,000
GRAND TOTAL	1,000	1,300	2,500	5,300

NORTH COASTAL SUBREGION

TABLE NC-5

Recreational Navigation Needs, 1965-2020

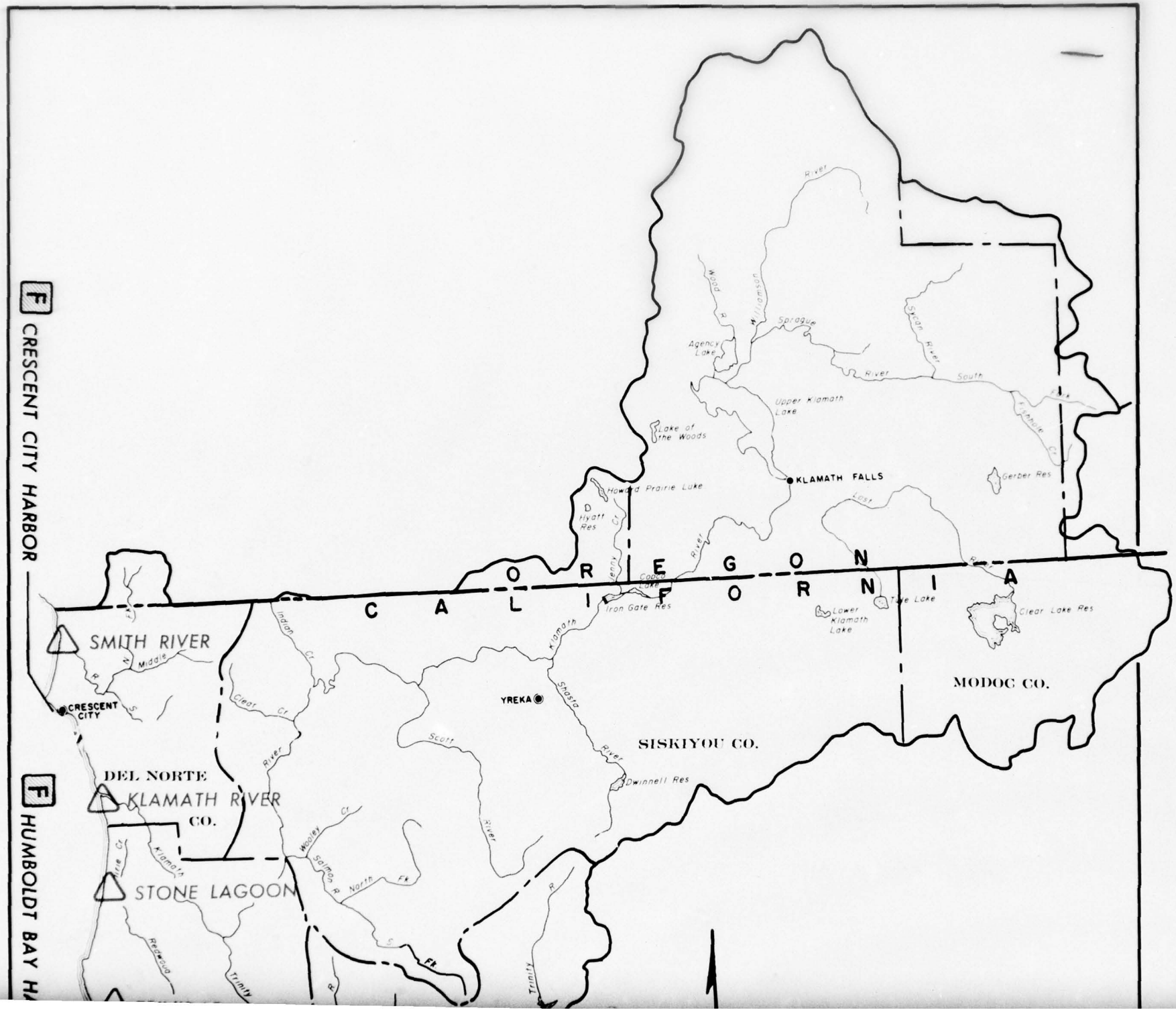
	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	4.5	5.0	5.5	6.0
Subregion population thousands	230	260	450	880
Number of berths needed	1,000	1,300	2,500	5,300
Trailered boats				
Number of trailered boats using navigable waters	5,400	7,500	16,000	35,000
Number of peak-day launchings	1,300	1,800	3,300	7,000
Launching facilities needed 1/	26	36	66	140
Transient boats				
Number of peak-weekend overnight-transient boats	700	900	1,600	3,000

1/ Launching lanes 12 feet wide or hoist with launching capacity of 50 boats per peak-day.

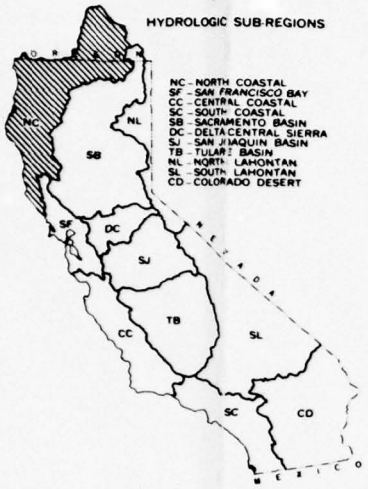
NORTH COASTAL SUBREGION
TABLE NC-6

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	1,000	300	1,300	1,200	2,500	2,800	5,300
Needs met:							
Within facilities existing in 1965	1,000	0	1,000	0	1,000	0	1,000
Within facilities definitely programmed in 1965	0	300	300	0	300	0	300
Within projected facilities not programmed in 1965	0	0	0	1,200	1,200	2,800	4,000
Incremental additions		300		1,200		2,800	
TOTAL	1,000		1,300		2,500		5,300
Residual un-met needs	0		0		0		0
Launching lanes							
Needs	26	10	36	30	66	74	140
Needs met:							
By lanes existing in 1965	26	0	26	0	26	0	26
By projected lanes	0	10	10	30	40	74	114
Incremental additions		10		30		74	
TOTAL	26		36		66		140
Residual un-met needs	0		0		0		0
Transient moorings							
Needs	700	200	900	700	1,600	1,400	3,000
Needs met:							
By moorings existing in 1965	700	0	700	0	700	0	700
By projected moorings	0	200	200	700	900	1,400	2,300
Incremental additions		200		700		1,400	
TOTAL	700		900		1,600		3,000
Residual un-met needs	0		0		0		0


F CRESCENT CITY HARBOR
F HUMBOLDT BAY HA
CALIFORNIA
OREGON
SMITH RIVER
CRESCENT CITY
DEL NORTE
KLAMATH RIVER
CO.
STONE LAGOON
YREKA
SISKIYOU CO.
MODOC CO.
KLAMATH FALLS
Agency Lake
Upper Klamath Lake
Lake of the Woods
Howard Prairie Lake
D Hyatt Res
Iron Gate Res
Copco Lake
Lower Klamath Lake
Tule Lake
Clear Lake Res
Gerber Res
Dwinnell Res
Sprague River
South Fork
Williamson River
Wood R
Indian Cr
Clear Cr
Scott River
Shasta River
Klamath River
Middle Fk
South Fk
North Fk
Salmon R
Wooley Cr
Trinity R
Redwood
Terwer Cr
Lost River


CRESCENT CITY
YREKA
MODOC CO.
SISKIYOU CO.
DEL NORTE
KLAMATH RIVER
CO.
F HUMBOLDT BAY HARBOR
STONE LAGOON
TRINIDAD
ARCATA
EUREKA
WEAVERVILLE
Lewiston Dam
Clair Engle Lake
Dwinnell Res.
EEL RIVER
TRINITY CO.
HUMBOLDT CO.
MATTOLE POINT
SHELTER COVE
ROCKPORT
MENDOCINO CO.
GLENN CO.
LAKE CO.
FT BRAGG
F NOYO HARBOR
Clear Cr
Scott River
Shasta River
Klamath
Redwood Creek
Trinity R
Mad R
Van Duzen R
Eel River
Mattole River
South Fork
Middle Fork
Black Butte
Deep Cr
Noyo R
Hayfork Cr
Indian Cr
Lake Pillsbury
HYDROLOGIC SUB REGIONS
NC - NORTH COASTAL
SF - SAN FRANCISCO BAY
CC - CENTRAL COASTAL
SC - SOUTH COASTAL
SB - SACRAMENTO BASIN
SJ - SAN JOAQUIN-CENTRAL SIERRA
TB - TULARE BASIN
NL - NORTH LAHONTAN
SL - SOUTH LAHONTAN
CD - COLORADO DESERT



LEGEND

EXISTING DEVELOPMENT (1965)

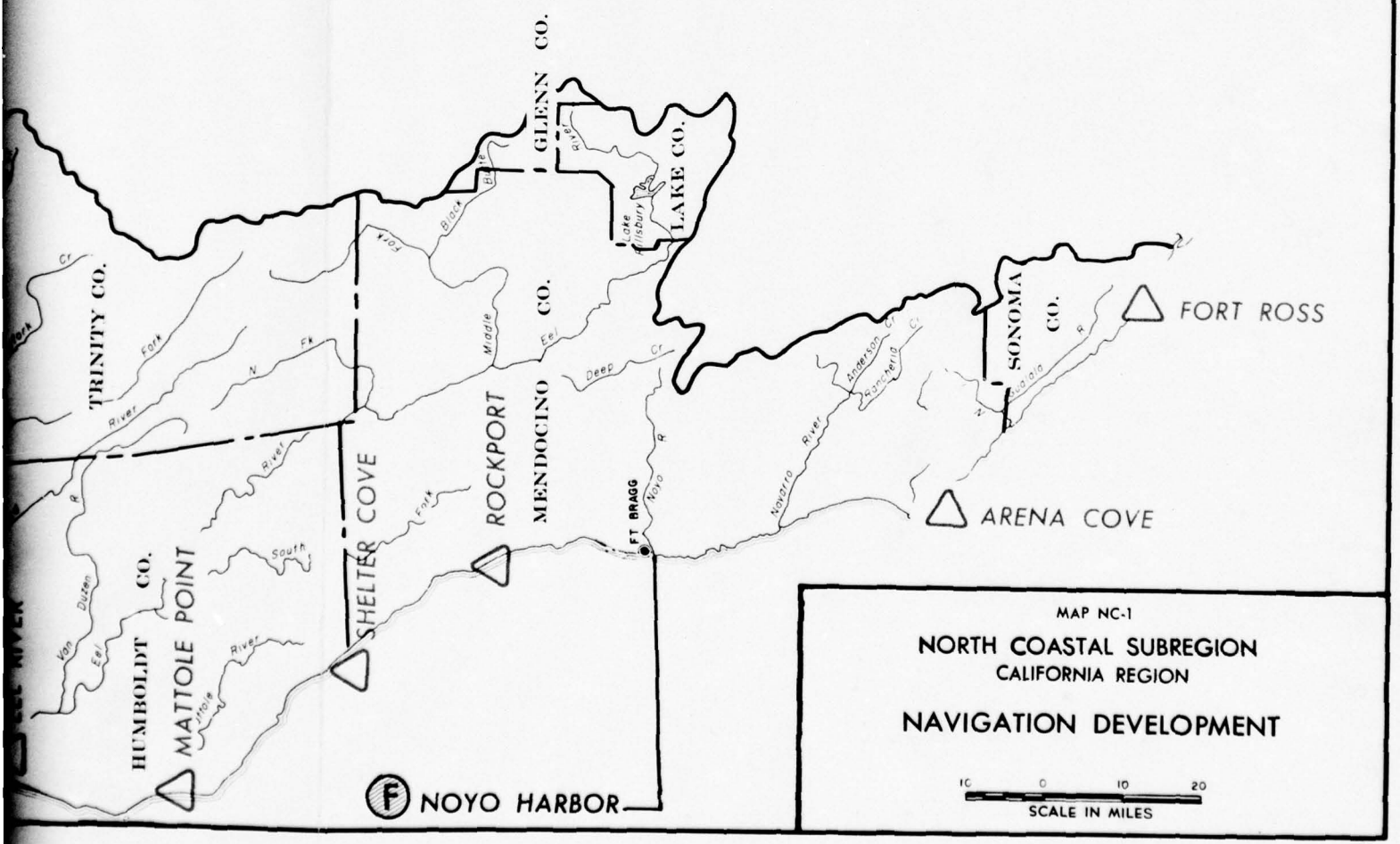
(F) Existing commercial Federal project harbor

(F) Existing recreational Federal project harbor

POTENTIAL DEVELOPMENT

Existing harbor requiring expansion, not programmed

△ Possible site for small-craft harbor to meet future requirements



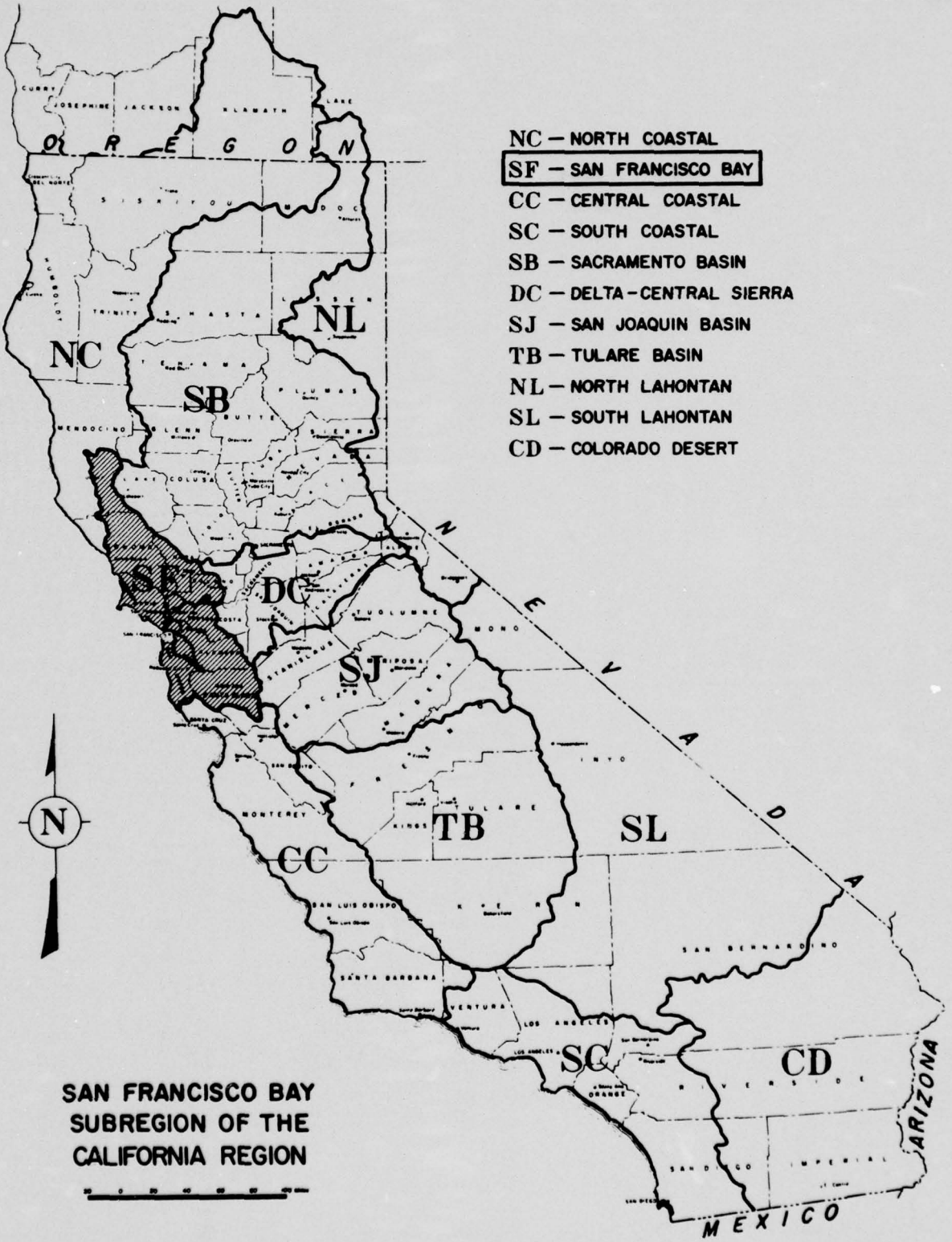
MAP NC-1

NORTH COASTAL SUBREGION
CALIFORNIA REGION

NAVIGATION DEVELOPMENT

10 0 10 20
SCALE IN MILES

SAN FRANCISCO BAY SUBREGION



SAN FRANCISCO BAY SUBREGION OF THE CALIFORNIA REGION

SAN FRANCISCO BAY SUBREGION

General

The San Francisco Bay subregion is located near the center of the Region's coast. It extends along the Pacific Ocean from the mouth of the Russian River in Sonoma County on the north to just south of Point Ano Nuevo in San Mateo County, and surrounds San Francisco Bay, the Region's largest bay. The subregion is described in detail in Appendix II.

About 23 percent of the Region's population lived in the subregion in 1965. The economy is dominated by highly diversified manufacturing, and service activities. Agriculture and related activities, shipping, and distribution also comprise major segments of the economy of the area.

During 1965 the waterborne commerce of the San Francisco Bay subregion exceeded 45,000,000 tons or approximately 50 percent of the total waterborne commerce for the entire California Region. Waterborne commerce through the ports of the San Francisco Bay System, summarized in Table SF-1, does not include commercial fishing cargoes of fresh fish and shell fish; commerce on the Napa River, Petaluma River and other streams tributary to the San Francisco Bay; or commerce at the Berkeley small-craft harbor or coastal small-craft harbors. It is estimated that these additional and miscellaneous articles of commerce amounted to approximately 1,000,000 tons in 1965. The principal commercial ports of the subregion are located within the San Francisco Bay system and are Redwood City Harbor, San Francisco Harbor, Oakland Harbor, Richmond Harbor and the terminal and harbor facilities in San Pablo Bay, Mare Island Strait, Carquinez Strait and Suisun Bay. (See Map SF-1).

Through 1965, the Federal cost of navigation improvements in the subregion amounted to about $25 million for construction and about $40 million for maintenance. About one-fourth of the construction cost have been expended for harbor improvements along the coast, and almost all of the maintenance cost has been expended within the San Francisco Bay system, primarily for maintenance dredging of navigation channels and for removal of debris from bay waters.

Channels of the San Francisco Bay complex serve most of the ports of the subregion and, in addition, provide the only sea access to ports in the adjacent Delta-Central Sierra subregion. Landward, the ports of the subregion serve primarily the southwestern United States. Seaward, they primarily serve Alaska, Hawaii, Washington, Oregon, Texas and the gulf States, Florida, Canada, South America, Europe, the Far East and Asia. Crude petroleum and petroleum products are the major commodity of waterborne commerce in the subregion. Approximately 35,000,000 tons of crude petroleum and petroleum products passed through ports of the San Francisco Bay complex in 1965. This represents about 75 percent of the total waterborne commerce of the subregion.

Approximately 13,000 small craft were berthed in the San Francisco Bay subregion in 1965. Of these about 12,000 were pleasure craft, and the remainder were commercial fishing boats. Recreation craft berthed in the subregion comprise about 30 percent of all recreational boats berthed in the California Region. Approximately 60,000 trailered boats use the San Francisco Bay and coastal waterways and launching facilities.

Recreational boats may navigate from the 420 square miles of surface water in San Francisco Bay Area to the open sea and to the coastal harbors or they may navigate upstream into the Delta waters and the numerous tributary streams which flow into the San Francisco Bay system.

Existing Development

COMMERCIAL NAVIGATION

General

Virtually the entire volume of waterborne commerce of the San Francisco Bay subregion passes through the numerous port facilities of the San Francisco Bay system. Commercial navigation in other areas of the subregion is negligible. Waterborne commerce statistics are shown on Table SF-2 Locations of major harbors and terminals are shown on Map SF-1. Other harbor and port facilities of the subregion provide for military shipping activities, commercial fishing and recreational boating. The principal deep-draft ports include San Francisco Harbor, Oakland Harbor, Richmond Harbor and Redwood City Harbor. These terminal facilities and numerous other public and private harbor facilities of the San Francisco Bay system are served by approximately 80 miles of Federally-constructed and maintained navigation channels. Nearly two-thirds of the Federal channels are dredged to depths in excess of 30 feet. Under existing authorizations, approximately 60 miles of connecting channels are to be improved and maintained to depths in the 35-55 foot range. Terminal facilities include approximately 170 berths and 1,700 acres of supporting cargo-handling area. Excluded are a substantial proportion, presently estimated at 40 percent, of terminal facilities which are inadequate or substandard and require extensive modification to meet contemporary shipping requirements. Extensive modernization and expansion of existing terminal facilities is now underway and planned for the future to meet current and projected commercial shipping requirements. Current and projected physical data on subregion navigation features and terminal facilities are shown in Table SF-3.

Major Navigation Facilities of the San Francisco Bay Complex

The entrance channel across the San Francisco Bar is about 2,000 feet wide and 50 feet deep just offshore of the Golden Gate. Entering vessels may steer to the right shore and berth at the facilities of San Francisco Harbor or proceed to the South Bay and Redwood City Harbor.

Oakland Harbor lies directly across the bay from San Francisco Harbor in an easterly direction. In the North Bay, the Port of Richmond is situated on the east bank and the Richmond Long Wharf is situated just north of the Port of Richmond. The Long Wharf is a private operation of Standard Oil Company (Chevron Shipping) and vessel traffic is essentially limited to oil tankers. San Rafael Creek, a navigable stream, enters the North Bay from its easterly shore. Petaluma River and Napa River are navigable streams that enter San Pablo Bay from the northwest and northeast shores. Off the southerly shore at Davis Point, just downstream of the Mare Island Strait and Carquinez Strait, a privately owned and operated pier, Oleum Pier, serves the Union Oil Company refinery. Just upstream of Carquinez Strait the Port of Benicia, off the north shore, provides port facilities for general shipping and the newly constructed refinery of Humble Oil Company. On the opposite shore at Martinez the Shell Oil Company operates a pier for oil tankers. Farther to the east, on the south shore of Suisun Bay, the Phillips Petroleum Company operates the Amorco and Avon piers to load and unload its tankers. At the easterly boundary of Suisun Bay, and of the subregion, a site on the south shore has been selected for an oil tanker docking facility by the Douglas Oil Company.

San Francisco Harbor

San Francisco Harbor provides about 100 berthing spaces alongside some 40 deepwater piers to accommodate an average of approximately 200 ships per month. All piers are served by railroad spurs and accommodate vessels of 35-foot to 40-foot draft. Eighty percent of the traffic is general cargo. Containerized shipments are handled at the Islais Creek terminal. Special terminals handle imported automobiles, bulk liquids, newsprint, grain, cotton and copra. Total commerce amounted to about 5,000,000 tons in 1965, about ten percent of the subregion's waterborne commerce. Principal items of commerce are petroleum products, farm products, metal products and numerous miscellaneous items. Three transcontinental railroads, numerous major trucking lines and a major commercial airport serve the harbor area.

Federal improvements, authorized by various River and Harbor Acts from 1927 to 1937, include a channel 50 feet deep and 2,000 feet wide through the San Francisco Bar; the removal to a depth of from 40 to 35 feet of numerous rocks and shoals within the bay; an approach area to Islais Creek, 35 feet deep; and a channel 750 feet wide and 10 feet deep to San Francisco Airport ending in a basin approximately 2,000 feet wide and 10 feet deep. All of the authorized construction has been completed by the Corps of Engineers. This includes previous projects, no longer operative authorized by River and Harbor Acts from 1868 to 1922. Federal first costs totaled about $3,000,000 and cumulative maintenance costs, to date, primarily for maintenance dredging of the San Francisco Bar

Channel and debris removal, amount to approximately $8,500,000. A Federal navigation project for a deepwater channel from San Francisco Bay to Stockton, California (John F. Baldwin and Stockton Ship Channels) has been authorized by the 1965 River and Harbor Act, as set forth in House Document 208, 89th Congress, 1st session. The portion of the deepwater channel plan which would directly affect San Francisco Harbor is the deepening of the San Francisco Bar Channel from 50 feet to 55 feet.

Redwood City Harbor

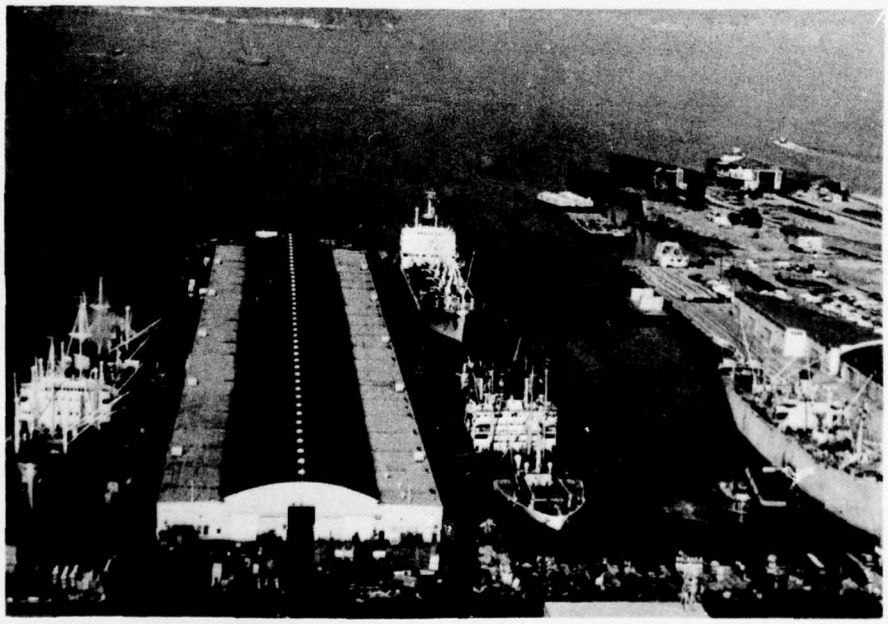
The Redwood City Harbor port district controls about 200 acres of land. Nine berths at the port can accommodate oil tankers and freighters of up to 30-foot draft. Principal articles of commerce are marine shells, petroleum products, salt, cement and gypsum products. The harbor is served by the Southern Pacific Railroad, and a local freeway connects with transcontinental highways. Total commerce amounted to about 3,500,000 tons in 1965, about seven percent of the total waterborne commerce of the subregion.

Previous Federal projects were authorized by the 1884 and 1902 River and Harbors Acts. The existing project was authorized by various River and Harbor Acts from 1910 to 1950. Authorized improvements constructed by the Corps of Engineers include dredging a channel 500 feet wide and 30 feet deep across San Bruno Shoal in San Francisco Bay; a channel 300 feet wide and 30 feet deep to the vicinity of the confluence of West Point Slough and Redwood Creek; a turning basin at that location 2,300 feet long and from 400 to 900 feet wide; a channel 400 feet wide, 30 feet deep and approximately 1,300 feet long widening into a second turning basin approximately 900 feet wide, 1,700 feet long and 30 feet deep; and a shallow channel 150 feet wide and 5 feet deep extending to Steinberger Slough. All authorized work was completed by the Corps of Engineers in 1965 and is under maintenance. Federal construction costs totaled approximately $1,800,000, including contributed funds from local interests of approximately $120,000. Approximately $2,000,000 has been expended by the Federal Government to date for maintenance dredging of channels. Studies are now under way to consider the economic feasibility of further deepening of the project channels.

Oakland Harbor

Oakland Harbor has 38 berthing spaces, including four which have been constructed at the 7th Street Terminal for container vessels. The port is served by 11 miles of dockside railroads and accommodates vessels of 30 to 35 foot draft. Traffic includes containerized and unitized cargo, break-bulk cargo, and bulk cargo. Total commerce amounted to about 5,000,000 tons in 1965, about ten percent of the subregion's waterborne commerce. Principal items of commerce are petroleum products, farm products, metal products and scrap, and numerous miscellaneous items. Three transcontinental railroads and several hundred trucking firms serve the harbor area.

The Embarcadero area of San Francisco Harbor handles primarily general cargo. (Corps of Engineers photo)



The Islais Creek area of San Francisco Harbor provides facilities for bulk and containerized cargo, as well as warehouses for general cargo. (Corps of Engineers photo)

Federal improvements, authorized by River and Harbor Acts from 1874 to 1910, are designated as previous projects, and have been superseded by the existing project as authorized by various River and Harbor Acts from 1922 to 1945. The Corps of Engineers has completed the existing project except for deepening of the tidal canal above Park Street Bridge from 18 feet to 25 feet. Completed work includes: dredging a channel in the outer harbor 35 feet deep and 600 to 950 feet wide, including a turning basin 35 feet deep and 950 feet wide; an inner harbor channel 30 feet deep varying from 275 to 800 feet in width to the Park Street Bridge, and continuing at a depth of 18 feet and a width of 275 feet to San Leandro Bay; a channel 25 feet deep and 300 feet wide at the north end of Brooklyn Basin; a north jetty and a south jetty at the entrance to the inner harbor, 9,500 feet long and 12,000 feet long, respectively; and four bridges across the tidal canal, two of which have been replaced by local interests to meet traffic needs for enlarged highway crossings. Federal construction costs totaled approximately $6,000,000, including contributed funds of nearly $100,000. Approximately $10,000,000 has been expended by the Federal Government to date for maintenance of the project. Modification of the existing Federal navigation project has been authorized by the 1962 River and Harbor Act, as set forth in House Document 353, 87th Congress, 2d session.

Richmond Harbor

Richmond Harbor includes numerous berthing facilities, many of which are operated in connection with shipbuilding activities, and others of which have been abandoned and are in various stages of disrepair. About 30 berths are now in use. The port is served by two mainline railroads and a dockside railroad facility. Local freeways provide access to transcontinental highways. The port accommodates vessels of from 30 to 35 foot draft. Commerce includes general cargo and dry and liquid bulk cargo. Total commerce amounted to about 15,000,000 tons in 1965, about one-third of the subregion's waterborne commerce. The principal item of commerce is petroleum, which accounts for about 95 percent of the waterborne commerce total (at the Richmond Long Wharf, Standard Oil docks). Other commodities of importance are machinery, metals, and scrap iron and pig iron.

The existing project was authorized by various River and Harbor Acts from 1917 to 1954. The existing project provides for a channel 35 feet deep and 600 feet wide through Southhampton Shoal to the outer harbor; an inner harbor entrance channel 35 feet deep and 600 feet wide to a turning basin at Point Richmond, thence continuing at the 35-foot depth with a width of from 500 to 600 feet to Point Potrero; an inner channel 35 feet deep and 850 feet wide to the entrance of the Santa Fe Channel and continuing at a depth of 30 feet through Santa Fe Channel and the turning basin: a rubblemound training wall 10,000 feet long (parallel to the channel between Point Richmond and Point Potrero) extending westerly from Brooks Island; an approach area 32 feet deep in the outer harbors at Point Orient and Point San Pablo; a channel 20 feet deep and 150 feet wide and about 2,000 feet long along the north side of Point San Pablo

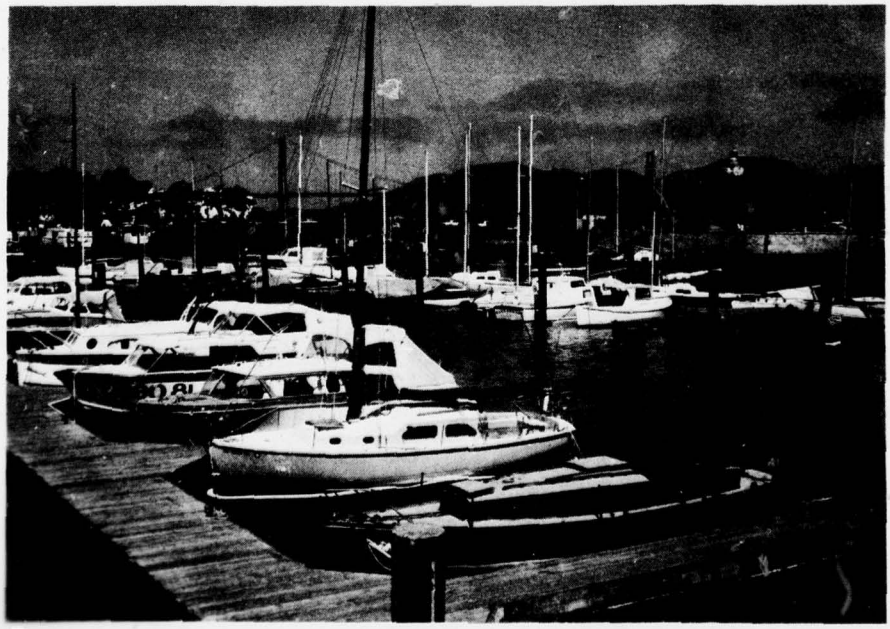
and a maneuvering area at the Richmond Long Wharf 35 feet deep. Construction of the existing project was completed by the Corps of Engineers, as authorized, and the project is now under maintenance. Federal construction costs totaled about $3,500,000, including a local cash contribution of approximately $500,000. About $4,000,000 has been expended for maintenance and rehabilitation to date by the Federal Government. The Federal navigation project for a deepwater channel from San Francisco Bay to Stockton, California (John F. Baldwin and Stockton Ship Channels) authorized by the 1965 River and Harbor Act, provides for the deepening of the Richmond Long Wharf maneuvering area to 45 feet deep and construction of a connecting channel, the West Richmond Channel, 45 feet deep, 600 feet wide and approximately 2.5 miles long through the west navigation opening of the Richmond-San Rafael Bridge. The overall project plan is contained in House Document 208, 89th Congress, 1st session.

San Pablo Bay and Mare Island Strait, Carquinez Strait, Suisun Bay and Napa and Petaluma Rivers

Except for the Port of Benicia, formerly a military facility, the San Pablo and Suisun Bays and the Carquinez Strait contain no public port facilities. The existing terminals and wharves serve specific industries, principally petroleum refineries. The Richmond Long Wharf, (included in the Richmond Harbor descriptions) serves Standard Oil; and the Oleum Pier, on the south shore of San Pablo Bay, is operated by the Union Oil Company. The Shell Oil Company at Martinez has wharves along the south shore, just upstream of the Carquinez Strait, in Suisun Bay; and Phillips Petroleum Company has its berthing facilities at Avon, just upstream of Martinez. The Humble Oil Company is completing construction of its refinery at Benicia and is using the Port of Benicia berthing facilities. Three other major oil company refineries are under construction or planned for early construction in the Carquinez-Suisun Bay area. The C & H Sugar Refining Corporation operates wharves at Crockett in the Carquinez Strait and Bethlehem Steel Corporation has its private docking facilities at Pinole Point in San Pablo Bay. Numerous additional wharves and piers are operated by private owners in the various inner bays and tributary areas on Napa River and Mare Island Strait, Petaluma River and San Rafael Creek. The general area is served by two mainline railroads, and access to transcontinental highways is provided by Interstate Highway 80 and local roads. Total commerce in the upper and inner bays and tributary rivers amounted to approximately 16,000,000 tons in 1965, about one-third of the subregion's waterborne commerce. Except for somewhat more than a million tons of sugar and molasses cargo, nearly all of the commerce consisted of crude petroleum and petroleum products. However, significant commerce in metal products and metal structures, salt, chemicals, sand and gravel are recorded.

The various River and Harbor Acts from 1902 to 1945 provide for construction and maintenance of a channel 35 feet deep, 600 feet wide and about 8 miles long in San Pablo Bay across the Pinole Shoal; a channel 30 feet deep and 700 feet wide through Mare Island Strait to a turning

Ship repair facilities and petroleum tanks at Point Potrero on Richmond Inner Harbor Channel. Waterborne commerce in this harbor consists mainly of petroleum products and general cargo.
(Corps of Engineers photo)



San Francisco Marina is typical of the recreational small-craft facilities in San Francisco Bay.
(Corps of Engineers photo)

basin about 1,000 feet wide between Vallejo and Mare Island; and two approach areas 20 feet deep to the waterfronts at Vallejo and South Vallejo; and for maintenance by the Corps of Engineers of two approach areas to the Navy Yard piers at the southern end of Mare Island. Construction was completed in 1943 except for the approach areas to Vallejo and South Vallejo. Construction costs of the Federal project amounted to approximately $1,400,000 including a local cash contribution of about $300,000. Approximately $11,000,000 have been expended by the Federal Government for maintenance of the project.

The existing Suisun Bay Channel Project is authorized by various River and Harbor Acts from 1927 to 1935, and (in 1963) under the authorities contained in Section 107 of the River and Harbor Act of 14 July 1960. The authorizations provide for construction of a navigation channel through the upper reaches of Carquinez Strait and the lower Suisun Bay 30 feet deep and 300 feet wide to Avon and 30 feet deep and 200 feet wide to Chipps Island. Approximately $3,000,000 of Federal funds have been expended on the project to date, including construction and maintenance costs. Expenditures for construction work have somewhat exceeded maintenance costs.

A channel 6 feet deep and 100 feet wide has been dredged at San Rafael Creek under Federal authorization. Federal expentitures to date amount to nearly $700,000, of which about 90 percent has been expended for channel maintenance dredging. To date, Federal expenditure of approximately $1,900,000 have been made for construction and maintenance of a channel 8 feet deep and 100 feet wide on Petaluma River. Of the total Federal expenditure, approximately $300,000 was for construction and $1,600,000 for channel maintenance dredging. Approximately $1,500,000 of Federal funds has been expended for construction and maintenance of a channel on Napa River, which varies from a depth of 15 feet and width of 100 feet in the lower reaches to a depth of 10 feet and a width of 75 feet in the upper reaches. Of the $1,500,000 of Federal funds expended for the project to date, about two-thirds has been expended for construction and one-third for maintenance.

The Federal navigation project for a deepwater channel from San Francisco Bay to Stockton, California (John F. Baldwin and Stockton Ship Channels), authorized by the 1965 River and Harbor Act, provides for the deepening of the Pinole Shoal channel through San Pablo Bay to a depth of 45 feet, and for the deepening of a maneuvering area adjacent to the Oleum Pier to a depth of 45 feet; modification of the existing Suisun Bay Channel Project by deepening to 45 feet; and widening the channel to 600 feet between Carquinez Strait and Chipps Island. The overall project plan is contained in House Document 208, 89th Congress, 1st session. Tables SF-1, SF-2 and SF-3 include subregion data on waterborne commerce and on navigation improvements and terminal facilities.

RECREATIONAL NAVIGATION

General

In 1965 about 12,000 recreational small craft were permanently berthed or moored in the San Francisco Bay subregion. The locations of major harbors and marinas is shown on Map SF-2. Data on berthing facilities in the subregion, by counties, are given in Table SF-5.

Trailered-boat facilities are located within the various coastal small craft harbors, coves, bays, lagoons and streams, and within the San Francisco Bay complex and tributary streams. Facilities consist of hoists or ramps for placing trailered small craft into the water, and of dry-storage, or space where a boat may be stored ashore near the launching facility. An inventory made by the State of California Department of Harbors and Watercraft indicates that there were approximately 200 "equivalent lanes" of launching facilities in 1965. An equivalent lane consists of a 12-foot wide ramp, or a hoist with equal launching capability.

Federal small-craft facilities in the subregion include Bodega Bay Harbor and Half Moon Bay Harbor (see map SFB-2). There has also been Federal participation in Berkeley Harbor, within San Francisco Bay, to the extent of constructing a detached breakwater to protect the existing harbor, which was constructed by non-Federal interests.

The Federal first costs for small-craft navigation improvements, through 1965, in the San Francisco Bay subregion amounted to approximately $7,500,000. Federal maintenance and rehabilitation work has cost approximately $500,000. Required local cooperation has amounted to $100,000 of cash contribution. In addition, local interests have provided berthing and supporting shore facilities, most of which are self-liquidating revenue-producing features. Within San Francisco Bay, non-Federal public and private interests have constructed over 80 marina areas that provide berthing for small craft. The total cost of installing these facilities is not known definitely, but would approximate $10 million.

The adequacy of existing small-craft harbors is adversely affected by the following conditions:

(1) Entrance conditions at several of the coastal embayments and estuaries are hazardous and not available for refuge during periods of heavy seas. The Corps of Engineers is conducting studies to determine the feasibility of constructing necessary improvements at these sites.

(2) The optimum spacing of 35 miles between harbors of refuge is exceeded, particularly along the southerly coast and extreme north. Studies now underway by the Corps of Engineers involve consideration of the economic feasibility of construction of a chain of harbors of refuge which meet the 35-mile spacing criteria.

(3) Use of the San Francisco Bay complex by pleasure craft causes some concern to commercial shipping operating in the channels of the component bays.

In 1965 facilities for permanently berthed and moored pleasure boats totaled about 12,000, which was approximately equal to the existing demand. It is considered that existing launch ramps and boat hoists were adequate; however, numerous additional coastal launching sites would be desirable to provide more immediate access to sports fishing areas along the coast.

Berths and moorings for temporary use by cruising vessels are available throughout the subregion and are normally adequate to meet the demand.

Future Needs

COMMERCIAL NAVIGATION

General

The future needs for commercial navigation were assessed in terms of projected waterborne commerce tonnages, considered in terms of commodity classes. The bases for the projections are discussed in the following paragraphs. Projection are shown in Tables SF-1 and SF-2.

Petroleum and Petroleum Products

Approximately 30 percent of the west coast petroleum refining capacity was located in the San Francisco Bay subregion in 1965. Substantial increases in subregion production of petroleum and petroleum products during the study period are indicated by revised studies which are based upon data contained in the Technical Report on San Francisco Bay Barriers, March 1963, and the Review Report on Navigation, San Francisco Bay to Stockton, 15 November 1963. These data were modified to reflect current data and Base Plan population and related economic projections. Increased channel depths will be required to accommodate oil supertankers of up to 70-foot draft and 350,000 deadweight tons. Such dimensions are required to assure competitive economy of transport by water for Alaskan and foreign crudes and conservation of domestic resources.

Food, Primary Metals, Paper and Chemicals

Shipments of food, primary metals, paper and chemicals were related to industrial production, employment, increases in production, and Base Plan population projections. Exports of farm products were considered roughly proportional to projections of gross farm output as made by the Economic Research Service, Department of Agriculture (ERS), for the Water Resources Council. Waterborne commerce relating to an integrated steel mill is included in the projection on the basis that a steel plant is

planned for construction during the decade 1980-1990 with a projected capacity of 6,000,000 tons of ingots per annum.

Miscellaneous Waterborne Commerce

Bulk commodities, salt, gypsum, cement, lumber and wood products, and canned fruit were related to population increases in major consuming areas for these commodities.

RECREATIONAL NAVIGATION

General

Projections of future boat ownership were based on the methodology used in the "California Small Craft Harbors and Facilities Plan, Comprehensive Report," dated March 1964, prepared by the State of California adjusted to reflect subsequently available data. The future needs were assessed in terms of permanent berthing facilities, launching facilities and transient and destination facilities. These needs are discussed in the following paragraphs and are summarized on Table SF-4.

Berthing Facilities

Present and projected needs for berthing facilities were based upon evaluation of the positive effects of increased disposable income on berthable boat ownership and the moderating effects of saturation factors and congestion that tend to reduce the desirability of boating as a means of recreation. Ratios of berthable boats per thousand population for the San Francisco Bay subregion are 3.0 in 1965, 4.0 in 1980, 5.0 in 2000 and 6.0 in 2020. Table SF-5 indicates the estimated requirements for berthing facilities to meet projected demands. It is anticipated that the total demand generated within the San Francisco Bay subregion by the year 2020 will be met by facilities constructed within the subregion boundaries. Incidental demands satisfied elsewhere in adjacent subregions would be offset by "foreign" demands satisfied within the subregion.

Trailered-boat Facilities

The present and projected needs for trailered-boat facilities were based upon the estimated use of bay and ocean waters by trailered boats as presented in the "Comprehensive Report" and modified as previously stated. These data summarize the percentage of trailered boats using the ocean by length and the average of days use and were used to estimate the number of peak-day launchings. The peak-day launching criteria, 50 boats a day launched and recovered per "equivalent" launching lane, were used to determine the number of launching facilities required.

Transient and Destination Facilities

The need for transient and destination facilities was based on data contained in the "Comprehensive Report." Transient and destination facilities would consist of berths, moorings and anchorage areas for overnight and vacation use by cruising boats and would also provide protected refuge from storms. Transient and destination facilities would also include fueling facilities, potable water, emergency assistance, and boat supply and repair facilities, and sanitary facilities. The estimated annual days of overnight and vacation use away from home port by cruising boats totaled about 150,000 in 1965. Peak weekends required accommodations for about 5,000 boats. Future needs, estimated at the present rate of transient use per total number of recreational boats would be about 10,000 peak-day uses by 1980, about 15,000 by 2000 and about 25,000 by 2020.

Means To Satisfy Future Needs

COMMERCIAL NAVIGATION

General

The means to satisfy future needs for commercial navigation in the San Francisco Bay subregion would consist primarily of expanding deep-draft harbor facilities. However, the possibility of developing additional port sites in the San Francisco Bay complex merits consideration. A Federal project for construction of a channel 27 feet deep and 300 feet wide leading to the mouth of Guadalupe River was authorized by the 1935 River and Harbor Act. No work has been performed on this project; however, local interests have made inquires as to construction possibilities from time to time and it is to be anticipated that local recognition of harbor requirements will increase as the population pressures in Santa Clara County become more apparent. Accordingly, the probability of additional port development in the South Bay, as an alternate, warrants careful consideration. In the upper Carquinez Strait area the town of Benicia has converted a military facility, the abandoned Benicia Arsenal, into the Port of Benicia and a shoreline industrial complex that includes the new Humble Oil Company refinery. Other refineries now planned for the Town of Hercules and at the south shore of the easterly portion of Suisun Bay as well as currently proposed industrial developments in the San Pablo Bay and Suisun Bay areas will increase the probability of the development of additional port facilities. The possibility of a central terminal to provide for supertankers will be given consideration by the Corps of Engineers in its "In-Depth" Study, authorized by resolution of the Committee on Public Works, House of Representatives, on 19 October 1967. This type of study is desirable to provide comparative analyses of the economic "reasonableness" of expanding and deepening port facilities and channels of the San Francisco Bay complex as compared to the concept of providing one or more central terminals, to be shared on equal terms

by all. Many environmental and social considerations as well as economics are involved in this type of analysis and it is to be anticipated that many years will elapse before a final decision on this type of alternate development to accommodate commercial navigation will be reached.

The means to satisfy future needs are defined in terms of required navigation features and terminal facilities. Projected navigation features are described in terms of required controlling dimensions and are based upon the assumption that vessel waiting time for favorable tides would be completely eliminated. Projected characteristics of the largest vessels expected to call at the subregion's port and terminal facilities are based upon the assumptions that conventional monohull ships will continue to serve most of the needs of waterborne commerce and that present trends towards larger vessels will continue. LASH-type vessel characteristics were considered in connection with the planning of shallow-draft channels. The projected terminal facilities are based upon the assumption that present trends toward sophisticated cargo-handling techniques will continue. Projected cargo was classified by handling technique as liquid bulk, dry bulk, containerized or break-bulk cargo. Containerized cargo was considered to include all specially handled cargo shipped in homogeneous units. In estimating future needs for berths and backup acreage, it was assumed that all commodities would be handled by the most efficient means, limited only by their physical properties, and that land transportation at the ports would function efficiently.

Coastal Harbor Sites

The San Francisco Bay complex dominates the subregion with its shipping complex. No need for development of commercial navigation facilities outside of the bay is indicated. At Half Moon Bay Harbor, waterborne commerce in 1965 was limited to fresh fish and shellfish. Development of this site as a commercial harbor during the study period is not considered probable.

Authorized and Projected Navigation Features

Under existing authorizations, the San Francisco Bar Channel (Main Ship Channel) will be deepened to 55 feet, and the connecting channels within the northerly bays of the San Francisco Bay System will be deepened to 45 feet as far upstream as Chipp's Island. The Oakland Inner Harbor Channel will be deepened to 35 feet. As indicated in Table SF-3 these facilities will be in operation by the year 1980. The table also indicates that by the year 2000, the San Francisco Bar Channel would be deepened to 80 feet. This projected depth is based upon the assumption that a central terminal for oil supertankers would be located in the west central bay to accommodate 350,000 DWT tankers with a draft of 70 feet. Contemporaneous maximum depths of interior bay system connecting channels would

be 50 feet. This would be sufficient to accomodate tankers in excess of 200,000 DWT and the larger dry-bulk carriers. It is to be emphasized that these projections are subject to substantial modification on the basis of findings that will evolve from studies now in progress, and additional studies that may be made in the future. Although centralized terminals provide economies by eliminating duplicating facilities, such benefits must be weighed against the advantages of decentralization, such as encouraging competition and the right of each community or local governmental entity to determine its own economic future without excessive restrictions.

Terminal Facilities

Estimates of required terminal facilities were developed on the basis of the number of berths and related cargo-handling area required to handle the projected waterborne commerce at the various ports of the San Francisco Bay System. Adjustments were made for probable periods of berth occupancy, continuation of present and projected competitive practices and the capacities of cargo carriers of various types. The following tabulation indicates projected interrelationships between the number of berths available for each cargo classification and the projected acreages of supporting cargo-handling areas in each cargo classification.

	No. of berths			Cargo-Handling area (acres)		
Type	1980	2000	2020	1980	2000	2020
Liquid-bulk	47	49	56	500	600	700
Dry-bulk	45	46	48	400	450	500
Container	50	60	74	1,200	2,000	2,800
Break-bulk	48	55	52	400	450	500
TOTAL	190	210	230	2,500	3,500	4,500

Liquid-bulk commodities consist almost entirely of crude petroleum and petroleum products. Dry-bulk commodities include nonmetallic ores, coal and coal products, scrap steel, building cement, stone, clay and glass, grains and marine shells. Container commodities include any method of handling pre-packaged cargo, such as palletized lumber, unitized automobiles and container vans of miscellaneous cargos. Break-bulk commodities include cargos which because of excessive dimensions, weight or other characteristics are not suitable for containerization, bulk handling or unitization. About 10 acres of cargo-handling area, on the average, will be available for each berth for dry-bulk, break-bulk or liquid-bulk cargos. For containerized cargos the ratio of about 24 acrea of cargo-handling area to each

berth in 1980 will increase to about 38 acres per berth in the year 2020. The projected increases from 170 berths in 1965 to 190 in 1980 to 210 in 2000 and 230 in 2020 assumes that the number of ports and port facilities in the San Francisco Bay system will continue to increase and that each publicly operated port will operate "containerized" terminal facilities in addition to dry-bulk, break-bulk or liquid-bulk facilities. It is estimated that approximately 25 percent of existing terminal facilities, except those used for private industrial purposes (in the manufacturing process) are divided more or less equally among container, dry-bulk and break-bulk facilities. By the year 2020 containerized terminal facilities will probably increase to about one-third of the total. Cargo handling area will increase from 1,700 acres in 1965 to 4,500 acres in 2020. Included in the total are tank farms for handling receipt of crude petroleum, exports of petroleum products, temporary storage and marshalling yards for dry bulk, general cargo and containerized cargo and warehousing for in-transit storage.

Land Requirements

Land requirements will increase from 1,700 acres of cargo-handling area in 1965 to 4,500 acres in the year 2020. To achieve the required additional 2,800 acres of cargo-handling area about 5,600 acres would be needed, since about half the total area would be required for streets, utilities and service facilities. The necessary land could be obtained through use of presently undeveloped lands, through redevelopment of presently developed lands, or by reclamation of bay tidelands. Due to the shortage of both developed and undeveloped lands suitable for port expansion, it will be necessary to provide some of the required land by reclamation of bay tidelands. The ecologic value of tidelands is well documented, and creation of land through fill should, accordingly, be held to the irreducible minimum. The San Francisco Bay Plan, prepared by the Bay Conservation and Development Commission in 1969, recognized the need for some filling to provide for port expansion: but provided that any permitted fill should be in accord with an overall regional port development plan. The authorized "In-Depth Study", now in progress, will give full consideration to the environmental effects of tideland fill, as well as to the other environmental and social considerations involved.

RECREATIONAL NAVIGATION

Basis For Projections

The projected increase in demand for berthing facilities for recreational boating is based upon increase in per capita income and changes in income groupings during the study period. In order to meet the projected demands it is assumed that presently authorized Federal projects and improvements planned by the private sector will be developed to full capacity. Present and future development plans will reflect a substantial increase in Federal small-craft projects and a marked

decrease in non-Federal construction activities along the bay shoreline and tributary streams. Federal financing of larger projects at the less favorable sites will be required. Federal projects will also dominate development of coastal recreational harbors; however, non-Federal construction, particularly along coastal tributary streams, will continue to increase. Such non-Federal projects will probably be developed in conjunction with non-Federal recreation projects and resort area developments. About 75 percent of the berthing requirements would be met within the San Francisco Bay system and its tributary systems, and about 25 percent would be met along the coastal shoreline. Although Table SF-4 indicates an increase from 5,000 peak weekend transient boats in 1965 to 23,000 in 2020 it is anticipated that a substantial part of the transient requirement will be met through interchange of boats between harbors and use of anchorages in lieu of berths.

General

Map SF-2 shows major sites available for development of berthing facilities for recreational boating within the San Francisco Bay Subregion. The coastal embayments at Point Ano Nuevo, Half Moon Bay, San Pedro Bay, Bolinas Lagoon, Drakes Bay, Tomales Bay and Bodega Bay provide varying degrees of natural protection during storm periods. Complete protection from most storms is provided by the breakwaters constructed at Half Moon Bay by the Corps of Engineers. The projected berthing capacity of these, and other sites was estimated. Table SF-5 shows projected needs for berthing facilities for each county of the subregion with shoreline along the subregion coast and San Francisco Bay. The plan to meet needs for recreational navigation is summarized in Table SF-6. Table SF-4 shows an estimated 200 additional launching facilities for trailered boats constructed during each decade of the study period, on the average. Available launching lanes, or equivalent facilities, would increase from 200 in 1965 to 1,200 in 2020 to keep pace with doubling of the boating demand ratio and a nearly threefold increase in subregional population.

Implementation

Construction of about 10 miles of breakwaters and jetties, dredging of approximately 200 million cubic yards of material, and construction of a central terminal for supertankers would be required during the study period. Estimated quantities by period are as follows:

Item	Unit	1966-1980	1981-2000	2001-2020
Commercial Navigation				
Dredging				
Federal	Cu. yds.	56,000,000	70,000,000	60,000,000
Non-Federal				
Public	Cu. yds.	1,000,000	800,000	900,000
Private	Cu. yds.	800,000	600,000	700,000
Recreational Navigation				
Breakwaters and jetties	Lin. ft.	5,000	16,000	30,000
Dredging				
Federal	Cu. yds.	1,500,000	3,000,000	6,000,000
Non-Federal				
Public	Cu. yds.	350,000	800,000	1,750,000
Private	Cu. yds.	150,000	200,000	150,000

Maintenance would consist of maintenance dredging of navigation features and other water areas, and maintenance of protective structures. It is estimated that the average annual requirements for maintenance dredging would be as follows:

	Total cubic yards (thousands)			
	1965	1980	2000	2020
Commercial Navigation				
Federal	5,500	6,500	8,000	10,000
Non-Federal:				
Public	1,200	1,300	1,600	2,200
Recreational Navigation				
Federal	10	25	40	70
Non-Federal				
Public	8	12	16	25

Estimates of first costs and costs of maintenance, operation and replacement of projected improvements were based upon currently available data adjusted to 1965 price levels. Bases for cost estimates and cost allocations are set forth in the regional summary.

Total construction costs for the navigation plan would amount to approximately $730 million during the study period. Commercial navigation features would involve expenditures of approximately $590 million and recreational navigation costs would amount to $144 million. The Federal investment would amount to $234 million, including $170 million for commercial navigation and $64 million for recreational navigation. The non-Federal costs would be $420 million for commercial navigation, including land acquisition and development, costs for cargo-handling areas, and about $80 million for recreational navigation. Estimated costs by time periods are as follows:

Summary of first costs

Feature	1965-1980	1980-2000	2000-2020
	(millions)	(millions)	(millions)
Commercial navigation			
Federal	$40.0	$ 80.0	$ 50.0
Non-Federal:			
Public	62.0	153.0	205.0
Recreational navigation			
Federal	9.0	22.0	33.0
Non-Federal:			
Public	15.0	28.0	37.0

Estimated maintenance costs would range from approximately $3.9 million per annum to $6.9 million per annum during the study period. Maintenance costs by time periods are as follows:

Summary of annual maintenance costs

Feature	1965-1980	1980-2000	2000-2020
	(millions)	(millions)	(millions)
Commercial navigation			
Federal	$2.0	$2.5	$3.0
Non-Federal:			
Public	1.5	1.9	2.2
Recreational navigation			
Federal	0.2	0.4	0.9
Non-Federal:			
Public	0.2	0.5	0.8

SAN FRANCISCO BAY SUBREGION

TABLE SF-1

Summary of Waterborne Commerce, 1/ 1965-2020

Type of Commerce	1965 2/	1980	2000	2020
Foreign Exports				
All ports				
Total, exports	2,904	3,510	5,190	8,080
Foreign Imports				
All ports				
Total, imports	6,085	24,220	50,080	88,420
Coastwise Shipments				
All ports				
Total, shipments	8,000	10,420	14,650	20,390
Coastwise Receipts				
All ports				
Total, receipts	11,717	15,700	19,610	21,960
Internal Shipments				
All ports				
Total, shipments	9,006	10,160	13,730	18,360
Internal Receipts				
All ports				
Total, receipts	7,738	9,430	13,700	17,240
Total Commerce				
All ports				
Grand total, subregion	45,450	73,440	116,960	174,450

1/ Thousands of short tons

2/ From "Waterborne Commerce of the United States, Part 4," Department of the Army, Corps of Engineers

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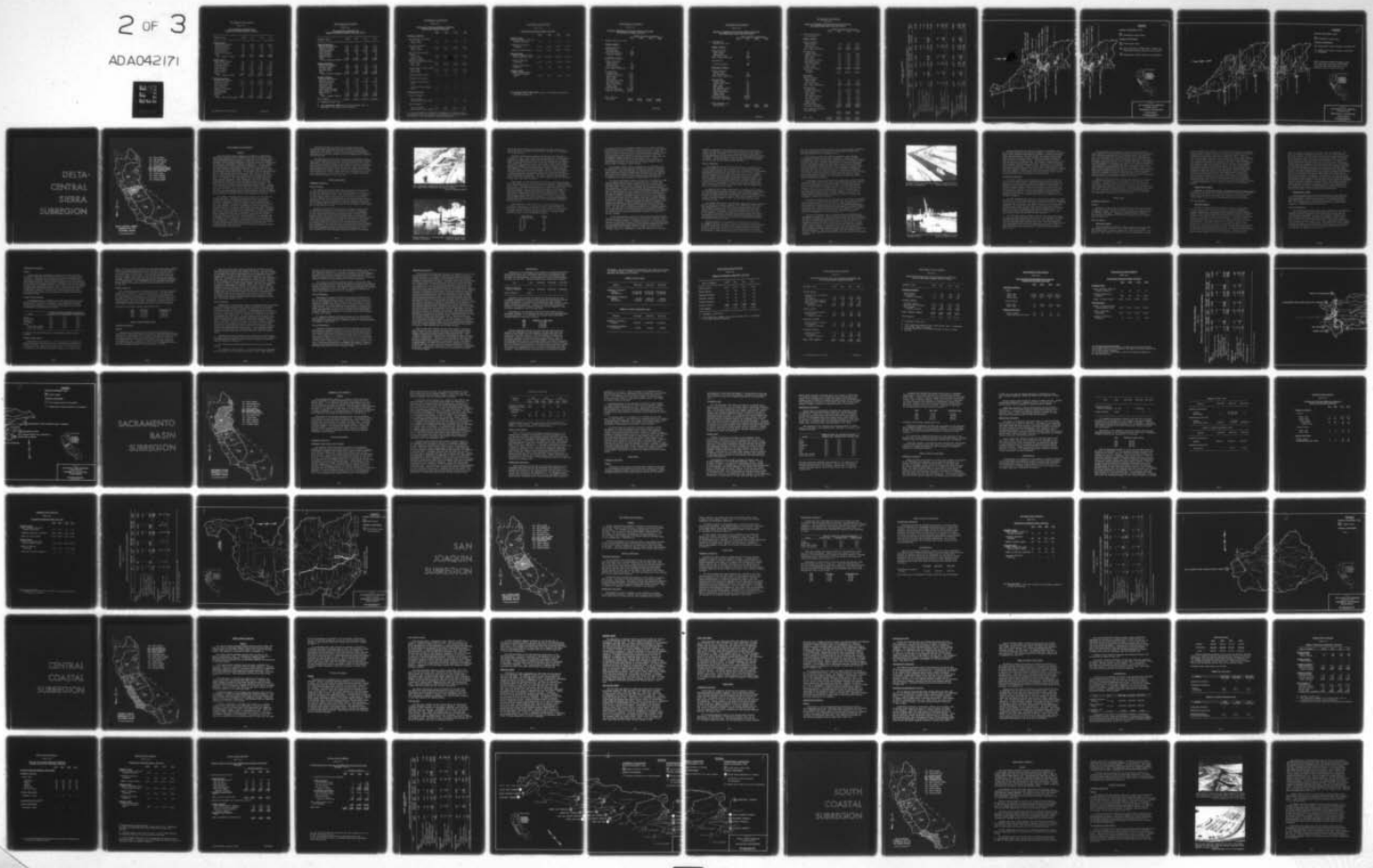


SAN FRANCISCO BAY SUBREGION

TABLE SF-2

1965 Waterborne Commerce[1/], and
Projected Waterborne Commerce 1980-2020

Commodity Group	1965[2/]	1980	2000	2020
Foreign exports				
Agricultural products	775	1,123	1,786	2,915
Chemical products	600	1,176	1,887	3,252
Petroleum products	466	150	100	50
Crude petroleum	32	0	0	0
Metal products	578	482	601	822
Nonmetallic minerals	0	0	0	0
Other	453	579	816	1,041
Total, foreign exports	2,904	3,510	5,190	8,080
Foreign imports				
Agricultural products	548	666	804	900
Chemical products	140	181	160	200
Petroleum products	980	750	700	590
Crude petroleum	3,395	14,000	30,300	62,800
Metal products	262	4,903	10,776	14,320
Lumber products	239	336	480	610
Coal products	0	2,700	5,800	7,600
Other	521	684	1,060	1,400
Total, foreign imports	6,085	24,220	50,080	88,420
Coastwise shipments				
Agricultural products	521	773	1,246	2,170
Chemical products	415	629	1,141	2,025
Petroleum products	6,298	8,100	10,800	14,100
Crude petroleum	160	0	0	0
Metal products	14	21	39	72
Nonmetallic minerals	0	0	0	0
Lumber products	28	67	160	350
Building cement	210	300	450	590
Machinery	48	67	100	118
Other	306	463	714	965
Total, coastwise shipments	8,000	10,420	14,650	20,390

See footnotes at end of table

Continued

SAN FRANCISCO BAY SUBREGION

TABLE SF-2

1965 Waterborne Commerce[1/], and
Projected Waterborne Commerce 1980-2020 (Cont.)

Commodity Group	1965[2/]	1980	2000	2020
Coastwise receipts				
Agricultural products	1,160	1,634	2,446	3,315
Chemical products	299	392	578	764
Petroleum products	5,004	4,580	5,750	7,069
Crude petroleum	4,859	8,750	10,400	10,300
Metal products	199	125	130	130
Lumber products	68	30	30	30
Building cement	7	10	10	20
Other	121	179	266	332
Total, Coastwise receipts	11,717	15,700	19,610	21,960
Internal shipments				
Agricultural products	346	510	760	975
Petroleum products	8,350	9,200	12,295	16,400
Building cement	166	240	370	590
Sand and gravel	84	120	180	230
Other	60	90	125	165
Total, Internal shipments	9,006	10,160	13,730	18,360
Internal receipts				
Agricultural products	290	429	624	802
Chemical products	11	13	21	27
Petroleum products	5,053	6,505	10,404	13,598
Crude petroleum	370	0	0	0
Nonmetallic ores	375	179	197	210
Building cement	52	65	66	66
Stone, clay and glass	14	55	78	98
Sand, gravel and rock	0	0	0	0
Marine shells	1,494	2,100	2,200	2,300
Other	79	84	110	139
Total, Internal receipts	7,738	9,430	13,700	17,240
Total commerce	45,450	73,440	116,690	174,450

1/ Thousands of short tons

2/ From "Waterborne Commerce of the United States, Part 4," Department of the Army, Corps of Engineers

SAN FRANCISCO BAY SUBREGION

TABLE SF-3

Existing and Projected Commercial Navigation Features and Terminal Facilities

	1965	1980	2000	2020
Navigation features:				
San Francisco Bar Channel				
Depth, feet	50	55	80	80
Length, miles	3	4	7	7
Deep-draft channels				
Depth, feet	30-35	35-45	35-45	40-50
Length, miles	45	55	60	70
Miscellaneous and inner channels				
Depth, feet	8-30	10-35	15-40	15-40
Length, miles	35	40	45	45
Deep-draft turning basins and maneuvering areas				
Depth, feet	30-35	35-45	40-45	40-45
Area, acres	550	1,150	1,350	1,600
Miscellaneous, turning basins				
Depth, feet	10-30	10-35	15-40	15-40
Area, acres	50	70	100	150
Anchorage areas, number	35	35	40	45
Protective Structures:				
Richmond Training Wall, miles	2	2	2	2
Levees and miscellaneous, miles	10	10	15	20
Terminal facilities:				
Central terminal:				
Berths, number	-	-	2	3
Cargo-handling area, acres	-	-	250	400
Major terminals:				
Berths, number[1/]	170	190	210	230
Cargo-handling area, acres	1,700	2,500	3,500	4,500

1/ Excludes substantial proportion (estimated at 40 percent in 1965) of facilities which are inadequate or substandard and require extensive modification to meet contemporary shipping requirements.

SAN FRANCISCO BAY SUBREGION

TABLE SF-4

Recreational Navigation Needs, 1965-2020

	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	3.0	4.0	5.0	6.0
Subregion population, thousands	4,000	5,700	8,400	11,200
Number of berths needed	12,000	22,000	42,000	67,000
Trailered boats				
Number of trailered boats using navigable waters	60,000	110,000	220,000	370,000
Number of peak-day launchings	10,000	19,000	37,000	62,000
Launching facilities needed 1/	200	400	700	1,200
Transient boats				
Number of peak-weekend overnight transient boats	5,000	9,000	14,000	23,000

1/ Launching lanes 12 feet wide or hoist with launching capacity of 50 boats per peak-day.

SAN FRANCISCO BAY SUBREGION

TABLE SF-5

Existing, Programmed and Projected Berthing Facilities for Recreational Boats, 1965-2020

	Number of Berths (Cumulative)			
	1965	1980	2000	2020
1. EXISTING FACILITIES (1965)				
Federal Projects				
Coastal shoreline	0			
Bay shoreline:				
Alameda County	600			
Total, Bay shoreline	(600)			
Subtotal, Federal	600			
Non-Federal Projects				
Coastal shoreline:				
Sonoma County	100			
Marin County	200			
San Mateo County	50			
Total, coastal shoreline	(350)			
Bay shoreline:				
Alameda County	2,000			
Contra Costa County	1,400			
Marin County	3,900			
Napa County	300			
San Francisco County	700			
San Mateo County	1,100			
Santa Clara County	300			
Solano County	1,300			
Sonoma County	50			
Total, bay shoreline	(11,050)			
Subtotal, non-Federal	11,400			
TOTAL, EXISTING FACILITIES	12,000	12,000	12,000	12,000

Continued

SAN FRANCISCO BAY SUBREGION

TABLE SF-5

Existing, Programmed and Projected Berthing Facilities for Recreational Boats, 1965-2020 (Cont.)

	Number of Berths (Cumulative)			
	1965	1980	2000	2020
2. PROGRAMMED FOR CONSTRUCTION (1965)				
Federal Projects				
Coastal shoreline:				
Sonoma County		450		
Marin County		300		
San Mateo County		50		
Total, coastal shoreline		(800)		
Bay shoreline		0		
Subtotal, Federal		800		
Non-Federal Projects				
Coastal shoreline:				
Sonoma County		100		
San Mateo County		100		
Total, coastal shoreline		(200)		
Bay shoreline:				
Alameda County		700		
Contra Costa County		350		
Marin County		550		
Napa County		100		
San Francisco County		350		
San Mateo County		200		
Santa Clara County		2,000		
Solano County		150		
Sonoma County		450		
Total, bay shoreline		(4,900)		
Subtotal, non-Federal		5,100		
TOTAL PROGRAMMED FOR CONSTRUCTION		5,900	5,900	5,900

Continued

SAN FRANCISCO BAY SUBREGION

TABLE SF-5

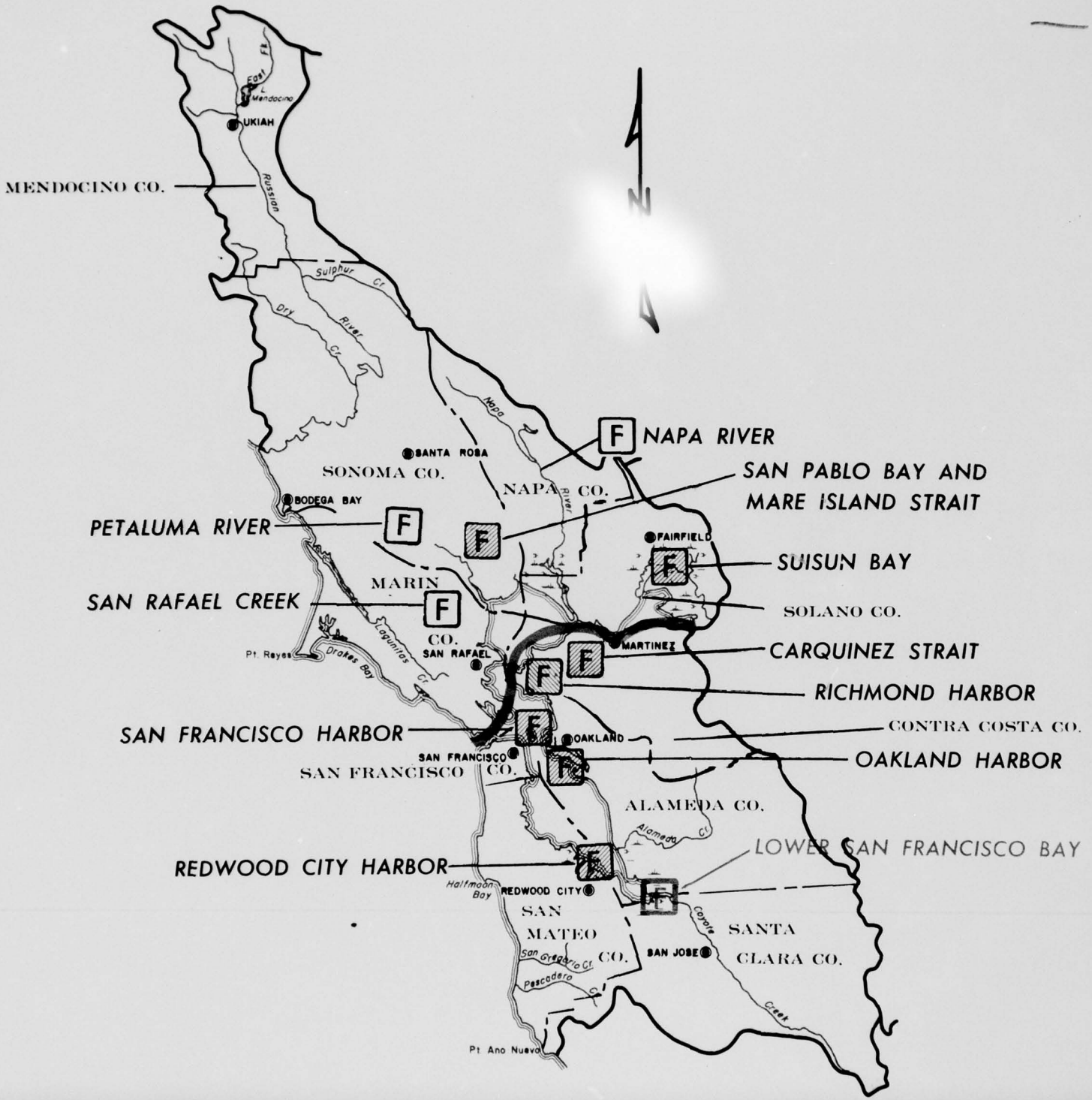
Existing, Programmed and Projected Berthing Facilities for Recreational Boats, 1965-2020 (Cont.)

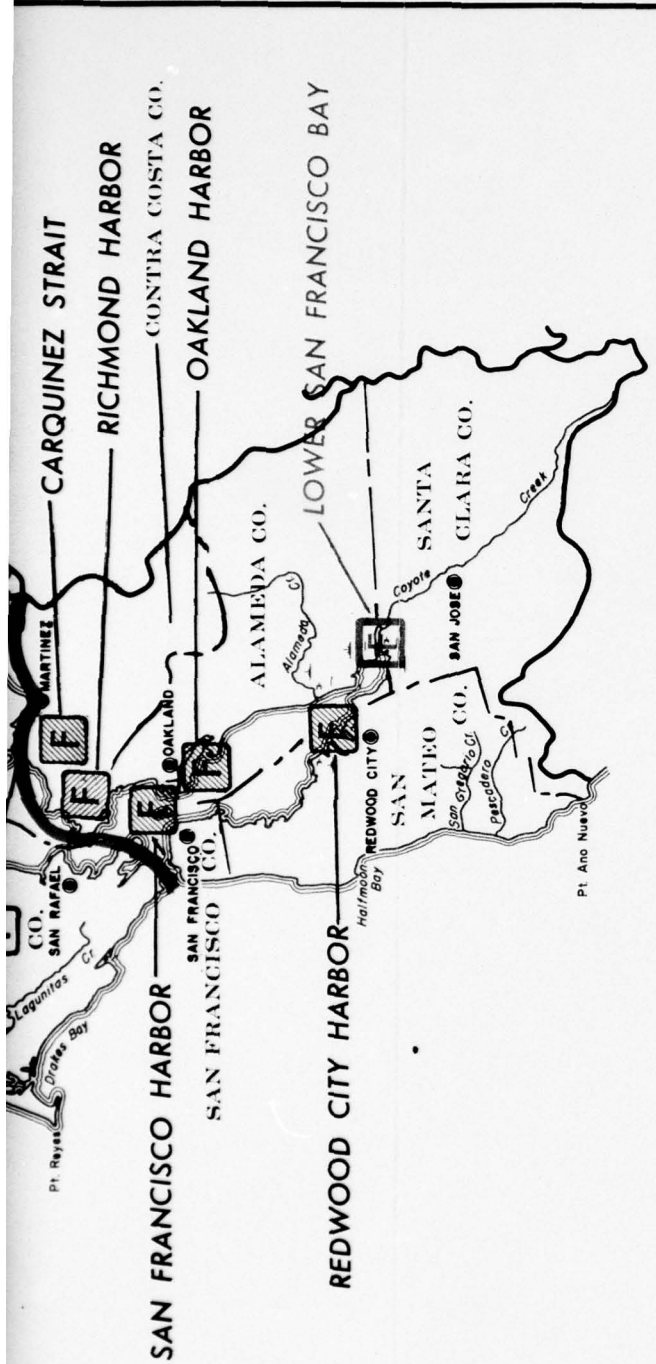
	Number of Berths (Cumulative)			
	1965	1980	2000	2020
3. PROJECTED FACILITIES NOT PROGRAMMED				
Federal Projects				
Coastal shoreline:				
Sonoma County		100	500	2,500
Marin County		50	2,400	7,400
San Mateo County		50	1,000	4,000
Total, coastal shoreline		(200)	(3,900)	(13,900)
Bay shoreline:				
Alameda County		100	1,400	3,000
Contra Costa County		100	1,200	3,000
Marin County		100	1,500	3,000
Napa County		100	900	1,700
San Francisco County		200	1,000	2,000
San Mateo County		100	1,200	3,000
Santa Clara County		200	1,800	4,000
Solano County		100	900	1,700
Sonoma County		100	900	1,700
Total, bay shoreline		(1,100)	(10,800)	(23,100)
Subtotal, Federal		1,300	14,700	37,000
Non-Federal				
Coastal shoreline:				
Sonoma County		100	200	500
Marin County		100	300	1,000
San Mateo County		100	800	1,700
Total, coastal shoreline		(300)	(1,300)	(3,200)
Bay shoreline:				
Alameda County		300	1,200	1,500
Contra Costa County		300	1,400	1,800
Marin County		400	1,700	2,000
Napa County		100	600	800
San Francisco County		200	600	1,000
San Mateo County		200	800	1,200
Santa Clara County		1,000	2,000	2,500
Solano County		100	500	600
Sonoma County		200	600	700
Total, bay shoreline		(2,500)	(8,100)	(8,900)
Subtotal, non-Federal		2,800	9,400	12,100
TOTAL PROJECTED FACILITIES NOT PROGRAMMED		4,100	24,100	49,100
GRAND TOTAL	12,000	22,000	42,000	67,000

SAN FRANCISCO BAY SUBREGION
TABLE SF-6

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	12,000	10,000	22,000	20,000	42,000	25,000	67,000
Needs met:							
Within facilities existing in 1965	12,000	0	12,000	0	12,000	0	12,000
Within facilities definitely programmed in 1965	0	5,900	5,900	0	5,900	0	5,900
Within projected facilities not programmed in 1965	0	4,100	4,100	20,000	24,100	25,000	49,100
Incremental additions		10,000		20,000		25,000	
TOTAL	12,000		22,000		42,000		67,000
Residual un-met needs	0		0		0		0
Launching lanes							
Needs	200	200	400	300	700	500	1,200
Needs met:							
By lanes existing in 1965	200	0	200	0	200	0	200
By projected lanes	0	200	200	300	500	500	1,000
Incremental additions		200		300		500	
TOTAL	200		400		700		1,200
Residual un-met needs	0		0		0		0
Transient moorings							
Needs	5,000	4,000	9,000	5,000	14,000	9,000	23,000
Needs met:							
By moorings existing in 1965	5,000	0	5,000	0	5,000	0	5,000
By projected moorings	0	4,000	4,000	5,000	9,000	9,000	18,000
Incremental additions		4,000		5,000		9,000	
TOTAL	5,000		9,000		14,000		23,000
Residual un-met needs	0		0		0		0


MENDOCINO CO.
UKIAH
Russian
Sulphur Cr
Dry Cr
River
SONOMA CO.
SANTA ROSA
BODEGA BAY
PETALUMA RIVER
NAPA CO.
Napa River
NAPA RIVER
SAN PABLO BAY AND
MARE ISLAND STRAIT
FAIRFIELD
SUISUN BAY
SOLANO CO.
MARIN
CO.
SAN RAFAEL CREEK
SAN RAFAEL
Pt. Reyes
Drakes Bay
Lagunitas Cr
MARTINEZ
CARQUINEZ STRAIT
RICHMOND HARBOR
CONTRA COSTA CO.
SAN FRANCISCO HARBOR
OAKLAND
SAN FRANCISCO
SAN FRANCISCO CO.
OAKLAND HARBOR
ALAMEDA CO.
Alameda Cr
LOWER SAN FRANCISCO BAY
REDWOOD CITY HARBOR
Halfmoon Bay
REDWOOD CITY
SAN
MATEO
CO.
San Gregorio Cr
Pescadero Cr
SAN JOSE
SANTA
CLARA CO.
Coyote
Creek
Pt. Ano Nuevo
N



LEGEND

EXISTING DEVELOPMENT (1965)

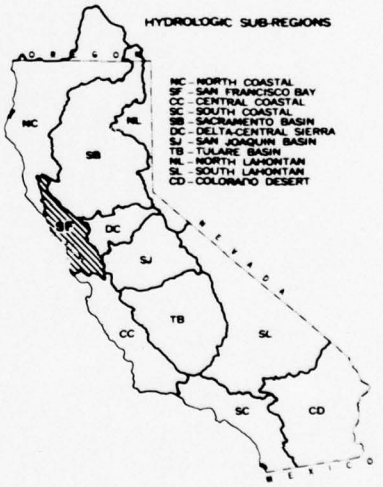
F Existing Federal project harbor

POTENTIAL DEVELOPMENT

F Federal harbor project

San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels), California, under construction

Existing harbor requiring expansion, not programmed



MAP SFB-1

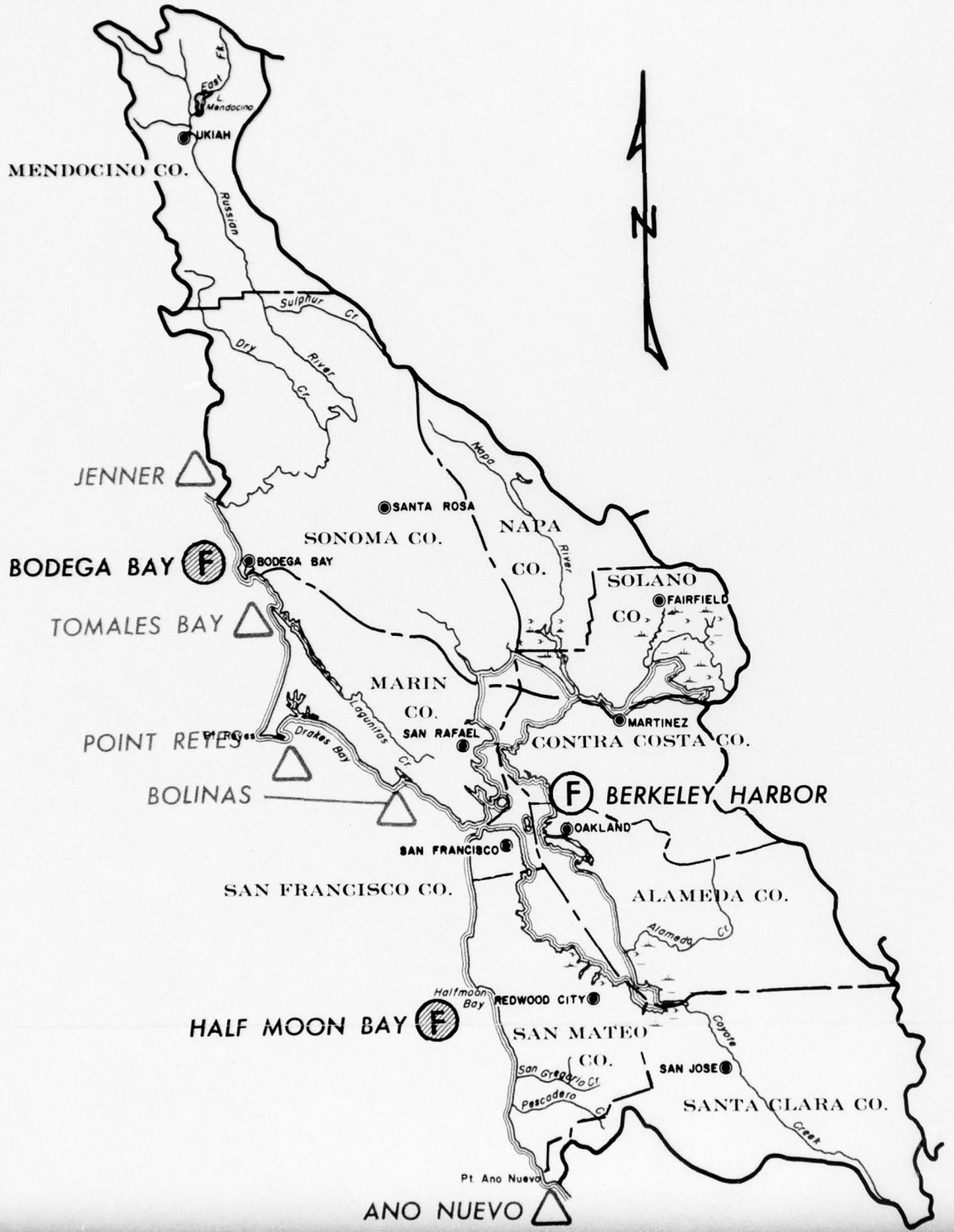
SAN FRANCISCO BAY SUBREGION

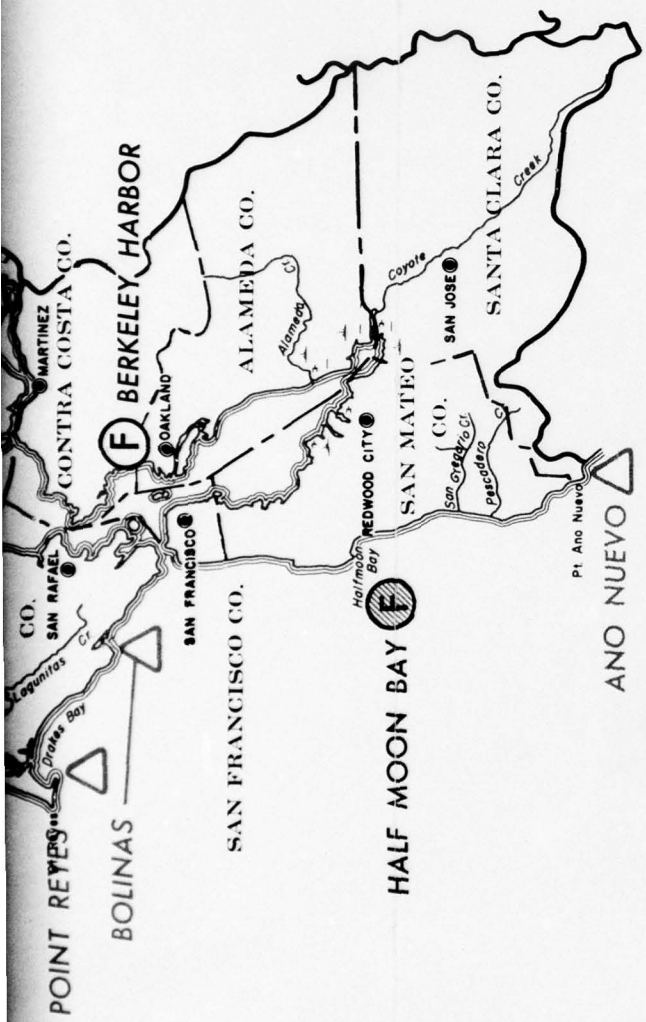
CALIFORNIA REGION

COMMERCIAL NAVIGATION DEVELOPMENT

10 0 10 20

SCALE IN MILES


MENDOCINO CO.
UKIAH
East Fk
L Mendocino
Russian
Sulphur Cr
Dry Cr
River
JENNER
SANTA ROSA
SONOMA CO.
NAPA
CO.
Napa
River
BODEGA BAY
BODEGA BAY
SOLANO
CO.
FAIRFIELD
TOMALES BAY
MARIN
CO.
Lagunitas Cr
MARTINEZ
POINT REYES
Pt Reyes
Drakes Bay
SAN RAFAEL
CONTRA COSTA CO.
BERKELEY HARBOR
BOLINAS
OAKLAND
SAN FRANCISCO
SAN FRANCISCO CO.
ALAMEDA CO.
Alameda Cr
Halfmoon Bay
REDWOOD CITY
HALF MOON BAY
SAN MATEO
CO.
San Gregorio Cr
Pescadero Cr
SAN JOSE
Coyote
SANTA CLARA CO.
Creek
Pt Ano Nuevo
ANO NUEVO



LEGEND

EXISTING DEVELOPMENT (1965)

(F) Existing Federal project harbor

POTENTIAL DEVELOPMENT

Existing harbor requiring expansion, not programmed

△ Possible site for harbor or marina to meet future requirements

NOTE: Existing and potential development within San Francisco Bay is not shown. Existing harbors and marinas, and possible future sites, are too numerous to show on a map of this scale.

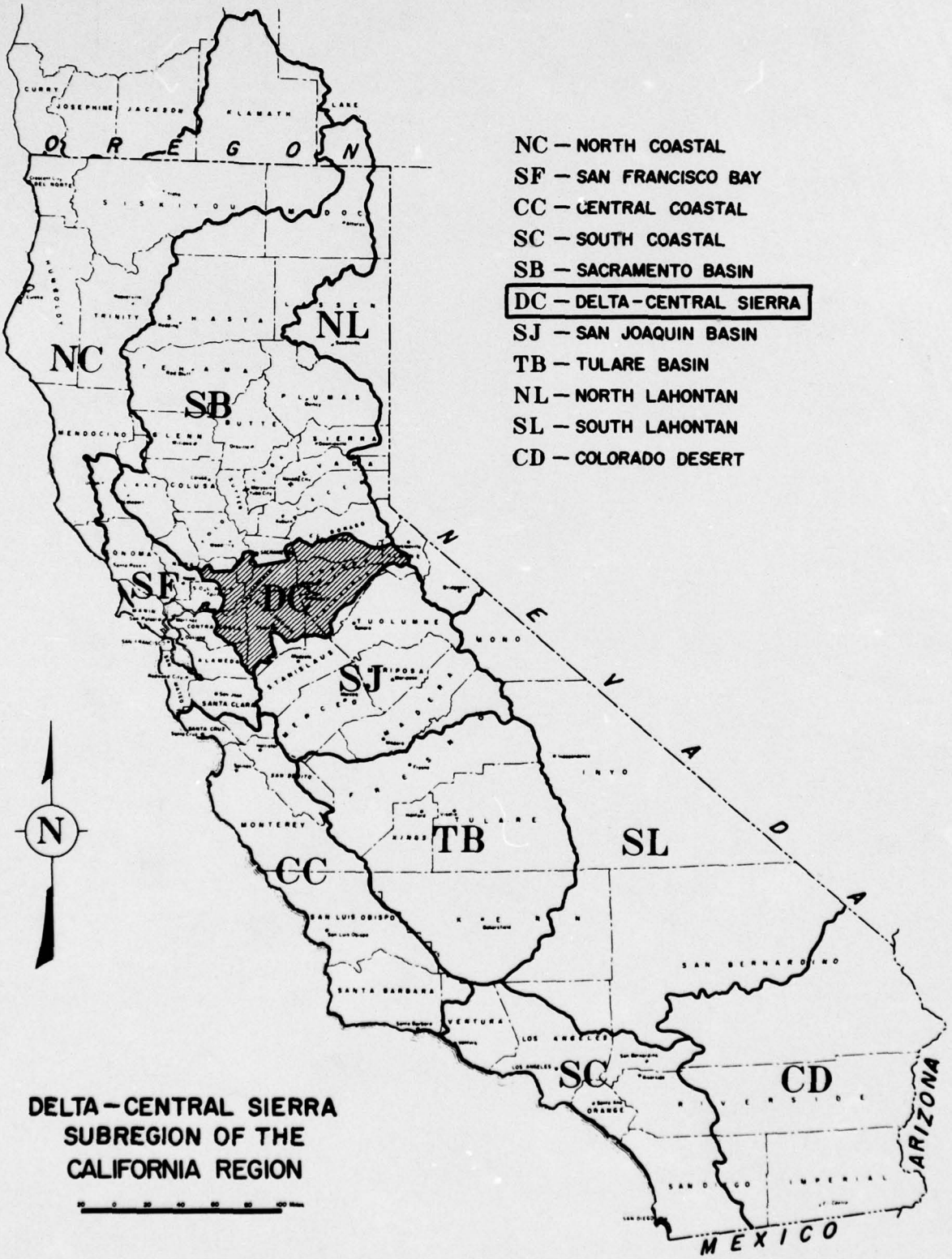
MAP SFB-2

SAN FRANCISCO BAY SUBREGION
CALIFORNIA REGION

RECREATIONAL NAVIGATION DEVELOPMENT

10 0 10 20
SCALE IN MILES

DELTA-CENTRAL SIERRA SUBREGION



DELTA-CENTRAL SIERRA
SUBREGION OF THE
CALIFORNIA REGION

DELTA-CENTRAL SIERRA SUBREGION

General

The Delta-Central Sierra subregion is situated in north-central California and extends from San Francisco Bay and the foothills of the Coast Range eastward about 130 miles to the ridge of the Sierra Nevada. The Delta-Central Sierra subregion is intimately tied to the adjacent Sacramento and San Joaquin subregions to the north and south, respectively. The subregion is described in detail in Appendix II. The only portion of the Delta-Central Sierra subregion of importance to navigation is the Sacramento-San Joaquin Delta, located in the western part of the subregion, comprising approximately 740,000 acres with some 100 leveed and reclaimed agricultural tracts. The Sacramento and San Joaquin Valleys are rich agricultural areas drained by the major rivers of the same names. These streams flow into the Delta, join, and empty into Suisun Bay, the most eastern arm of the San Francisco Bay complex (See Map DC-1). In addition to the major rivers, there are about 600 miles of interconnected, meandering, tidal waterways. Much of the Delta was originally an overflow area of the Sacramento River and a vast tidal swamp at about sea level, covered with water-loving vegetation. The Delta was first explored by Spanish expeditions prior to 1800. Because of the rich peat soil, the higher tracts were reclaimed for agricultural use in the mid-1800's, at the time of the great influx of migrants seeking gold. The main streams were originally important arteries of commerce. Later, debris from hydraulic mining operations was washed into the Sierra streams, shoaling the rivers and bays, and obstructing navigation.

Two important commercial navigation channels of 30-foot depth now traverse the Delta. Deep-draft ocean-going vessels use the lower Sacramento River and the Sacramento River Deep Water Ship Channel to the Port of Sacramento, and the San Joaquin River and Stockton Deep Water Ship Channel to the Port of Stockton. Shallow-draft traffic also uses these channels, as well as the Sacramento River to Sacramento, the Mokelumne River, Old River, Middle River, and other small connecting channels. There is considerable local interest in extending the authorized 45-foot channel in Suisun Bay to Collinsville to serve a projected water-related industrial area at that point. The Port of Stockton was opened to traffic in 1933 and, until 1963, served the entire 87,000 square-mile Central Valley area. With the opening of a deep-water port at Sacramento in 1963, there was a minor shifting in some traffic from the Stockton port to Sacramento, particularly rice from the Sacramento Valley. However, for the most part the Port of Sacramento has generated new traffic that probably would not have moved through Stockton. It is expected that if the Collinsville port complex is developed, it would largely generate new traffic also.

Shoreline vegetation in the Delta is lush and dense along the interconnected tidal waterways, and the Delta is an extremely popular year-round recreation area widely used for pleasure boating, water skiing, and fishing. In 1965, it is estimated that waterborne recreation use in the area totaled 2,780,000 recreation days, including 710,000 boat days.

All indications are that both commercial and recreational traffic will increase sharply in the future. Of particular importance to commercial ports in this subregion are the expected increase in size of new bulk carriers and modern methods of cargo handling, such as containerization and the lighter-aboard-ship (LASH) concept. These cargo-handling methods require especially designed terminal facilities and supporting land transportation systems. Rapid increases in population in the recreation tributary area (which extends beyond the subregion), more leisure time, and greater per capita income all indicate a growing demand for water-oriented recreation in the subregion.

Existing Development

COMMERCIAL NAVIGATION

Port of Stockton

The existing San Joaquin River project (Stockton Deep Water Ship Channel) was authorized by the River and Harbor Acts of 1927, 1935, and 1950, and completed in 1960. The project provides a 30-foot channel at mean lower low water, 400 feet wide, from Suisun Bay at Pittsburg to Venice Island, and 225 feet wide (250 feet in bends) from Venice Island to Stockton; channel improvements at Stockton; and other related developments. The Port of Stockton is located 75 nautical miles inland from the Golden Gate and approximately 40 miles upstream of Pittsburg. The San Joaquin River is tidal to Stockton, and the average tidal fluctuation at that port is 3.5 feet.

Originally the Port of Stockton served the entire Central Valley of California: however, since the opening of the Port of Sacramento in 1963, the local trade area of the Port of Stockton is principally the San Joaquin Valley and adjacent mountain areas. The San Joaquin Valley is one of the nation's richest agricultural areas, with many food processing plants and allied industries, and in recent years considerable diversified industry has developed in the basin. A large part of the bulk commodities exported through the port originate outside the immediate trade area, including ores from Nevada and Utah and grains from the Midwest. The deep-draft port was opened in 1933, and the annual port-generated payroll is now in excess of $40,000,000. The port has over 1,000 permanent employees and contributes substantially to the local economy, which has a critical unemployment problem, by providing

Port of Stockton, terminous of the Stockton Deep Water Channel, with eight ships at docks and one ship in channel.
(Corps of Engineers photo)

Boating recreation in the Delta area is enhanced by the scenic riparian environment. (Photo by Takashi Ueda)

direct and indirect employment opportunities for many people in the Valley who face a declining employment market because of the mechanization of agriculture.

Berthing facilities are available at Stockton for 15 vessels at a depth of 30 feet. These facilities include a 960- by 1,850-foot turning basin; 8 covered cargo berths with 600,000 square feet of transit sheds, 4 open cargo berths (including two bulk ore berths), one private berth for landing bulk grain, and 2 berths (one covered and one open) leased from a nearby United States Navy facility. Special bulk loading equipment is available for handling wine, molasses, minerals, and petroleum products. A 256-acre industrial park, zoned for heavy, medium, and light industry, adjoins the deep-water facility. The port operates 1,700,000 square feet of warehouse capacity in 30 units and provides a complete nationwide distribution service for 10,000 different articles for 110 marketing organizations. The port is served by its own belt-line railroad which connects with the Western Pacific, Santa Fe, Southern Pacific and 2 short-line railroads.

With respect to deep-draft traffic, Stockton is primarily an export port, and inbound traffic is minor compared to outbound. Outbound traffic at the Port of Stockton has increased from 377,000 tons in 1950 to 1,645,000 tons in 1965. Major commodities exported, in terms of tonnage, have been bulk iron ore, coke, and grains; farm products; canned goods; and wines and liquors. However, approximately 50 percent of the dollar value of all exports derives from dried fruits and grains, in about equal parts. Exports move chiefly to the trans-Pacific area, Europe, the Caribbean and the Intercoastal Waterway. The most important deep-draft imported commodities are petroleum products for the metropolitan Stockton area and bulk molasses, which goes to independent terminals in the port area.

Most deep-draft vessels calling at the Port of Stockton are of the general cargo type - C1, C2, C3, C4, and C4 Mariner classes or equivalent. Approximately 80 percent of the vessel calls in 1966, the only year for which detailed data are available, were of the C2 and C3 classes (12,500- to 14,300-ton cargo capacity). Outbound vessel traffic, by draft, in 1965 is summarized below.

Draft in Feet	Number
30 feet and more	31
28 - 30	62
26 - 28	56
24 - 26	88
22 - 24	72
20 - 22	0
18 - 20	43
Total	352

The present channel can accommodate vessels of up to about 25,000-ton cargo capacity, with loaded draft in excess of 31 feet, but such vessels require favorable tides to transit the San Joaquin River. Drafts of vessels inbound are generally less than those outbound; however, vessels that have greater cargo capacity and design draft than the channel accommodates frequently sail light even with favorable tides. The port is served on regular schedules by 32 steamship lines. In 1966, approximately 48 percent of the vessels calling at Stockton were of United States registry, 23 percent were of Asiatic registry, and 29 percent were of European or other registry.

The estimated Federal cost of completed work is $5,913,000, and the project cost to local interests, exclusive of terminal facilities, is $2,519,000. Local interest cost for terminal facilities provided under the terms of project authorization was $5,865,000. The Stockton Port District and private interests have invested additional funds in development of the terminal and the adjacent industrial park, and it is estimated that total investment is approximately $25,000,000.

The present deep-draft facilities of the Port of Stockton are inadequate to meet current demands of the tributary area. The two major immediate needs are for a deeper channel to permit the larger, more economical modern ships to call at Stockton and for improved cargo handling facilities. The 1965 River and Harbor Act authorized deepening the present 30-foot channel to 35 feet and straightening the most tortuous reach by construction of a cutoff through False River; however, construction has not yet been initiated. Completion of this authorized project will make it feasible for vessels of up to 40,000-ton cargo capacity to call at the Port of Stockton; delays in sailing due to low tide will be eliminated; better use can be made of cargo space by fully loading vessels which now sail light; and transit time and damages due to groundings will be reduced. Although specialized equipment is available for handling bulk materials, some is outmoded and no longer competitive, and the port has limited capability for handling containers and unit loads. The port plans to modernize and expand cargo handling operations in the next few years, including construction of a container station and a LASH terminal, at an estimated cost of approximately $10,000,000, and has received a grant from the Commerce Department for assistance for this program.

In 1965 approximately 28 percent of total Port of Stockton traffic was shallow draft, and the bulk of this shallow-draft (internal) traffic has been petroleum products. Pipelines have begun to supplement barge movement of petroleum products, primarily gasoline, in the Central Valley and are replacing barge movements to areas outside metropolitan Stockton. The other major shallow-draft commodity handled at the port is bulk molasses from Hawaii, transported by deep-draft sugar carriers to Crockett, where it is transferred to barges for movement to a molasses

terminal at Stockton. Most shallow-draft traffic in the San Joaquin Basin is handled through numerous privately owned dock facilities, not through the Port of Stockton. Many of these facilities are located on distributaries of the San Joaquin River and connecting Delta channels. In addition to numerous wharves, there are many bank landings, and some facilities. The San Joaquin River shallow-draft project is discussed more fully under the San Joaquin Basin subregion.

Port of Sacramento

The Sacramento Deep Water Ship Channel Project, authorized by the River and Harbor Act of 1946, includes: (1) a 30-foot ship channel 43 miles long from deep water in Suisun Bay to Sacramento, (2) a triangular turning basin 2,000 by 4,500 feet and 30 feet deep, and (3) a barge canal with navigation lock, with minimum depth of 13 feet, connecting the ship channel to the Sacramento River for shallow-draft traffic. The ship channel follows widened and deepened existing channels in the lower Sacramento River and Cache Slough and an excavated channel, with a depth of 30 feet and bottom width of 200 to 300 feet, north to the port. The Port of Sacramento is 79 miles inland from the Golden Gate, and the ship channel is subject to tidal action, with an average tidal range at the port of about 6.5 feet.

As early as 1911, studies were begun on a deep-water ship channel to Sacramento because sediment deposition in the Sacramento River (resulting from hydraulic gold mining) had made river navigation infeasible. Additional studies culminated in authorization of the ship channel project in 1946; construction was initiated in 1949, but was delayed by the Korean War and was resumed in 1956. The deep-draft port was opened to traffic in 1963.

The primary trade area is the Sacramento Valley and adjacent mountain areas, comprising 16 counties; however, such commodities as milo from Texas and powdered milk from Minnesota are exported through the port. The Sacramento Valley is one of the richest agricultural production centers in the United States, and adjacent mountain areas are rich in timber resources. Sacramento's industry historically has been tied to raw material processing (including agricultural products and lumber). The industrial base has been steadily growing and diversifying. Major transcontinental and north-south railroads and highways make Sacramento an important distribution center.

Berthing facilities are available at the port for five vessels at a depth of 30 feet, including 2 covered cargo berths, with approximately 180,000 square feet of transit sheds, three open cargo berths, and paved and covered bulk storage areas. Special equipment is available for bulk grain loading and storage, bulk mineral loading and storage, and containers. Large private developments adjacent to the port include

bulk rice loading and storage facilities and 3 large warehouse facilities. The port is served by its own belt-line railroad which connects with major railroads serving the Sacramento area.

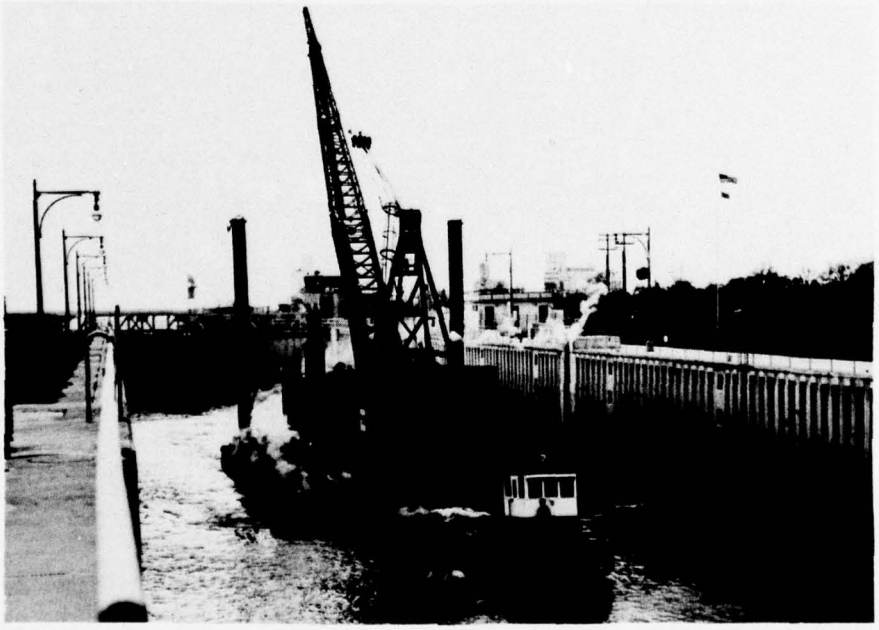
With respect to deep-draft traffic, Sacramento, like Stockton, is primarily an export port for bulk commodities. Because the Port of Sacramento is such a new facility, published data on oceanborne commerce carried to date give a somewhat distorted picture of the relative importance of deep-draft and shallow-draft traffic. In 1965 only 20 percent of the total traffic handled was deep-draft; however, such traffic has increased rapidly in subsequent years. Major commodities exported have been rice and grains; and the export of forest products, particularly wood chips and logs, has increased annually. Exports move chiefly to the Far East, with some traffic to Europe and other areas. Large shipments of rice have moved to Puerto Rico, Korea, Japan, and Viet Nam, while forest products move to Japan. The most important deep-draft imports have been machinery from Europe.

The Sacramento channel was designed to accommodate a loaded "Victory" class ship, with a draft of 28.6 feet. Although the channel has a nominal depth of 30 feet below mean lower low water, tidal conditions provide 33 feet of depth about 50 percent of the time. Vessels with loaded drafts of up to 34 feet have sailed from the port. The largest vessel to call at the port was of Korean registry, 692 feet long and with 98-foot beam, which sailed with 37,000 tons of cargo. In 1965 about 90 vessels called at the port (164 in 1968). Roughly, 55 percent of the vessels are of European registry, 30 percent of Asiatic registry, and 15 percent of United States registry.

The estimated Federal cost of completed work at the Port of Sacramento is $41,640,000, and the project cost to State and local interests, exclusive of terminal facilities, is $7,272,000. Local interest cost for basic terminal facilities provided under terms of project authorization was $10,741,000. Private interests have constructed and placed in operation facilities in the vicinity of the port which make use of the project (including a rice growers' cooperative mill and warehouse, a cement plant, and warehouses) at a total estimated cost of $7,000,000.

The Port of Sacramento has a continuing program of expansion and improvement of facilities. Equipment recently added includes a railroad car dumper, log-handling equipment, expansion of the bulk material handling facility, and additional paved storage area. In the near future the port plans to add an additional berth with paved backup area. The port predicts future traffic will be primarily bulk cargo and that a deeper channel will be required to accommodate the larger, newer bulk carriers and to handle the expected increased tonnage. The port has begun an active program to develop complete container terminal service for shippers and their customers. The service includes regularly scheduled barge service to carry containers to and from the port and all Bay area container terminals.

Sacramento River Deep Water Ship Channel with ship inbound to the Port of Sacramento. (Corps of Engineers photo)



The only navigation lock in the California Region is on the Sacramento River. (Corps of Engineers photo)

Shallow-draft traffic is also of importance to Sacramento, with the principal commodity being petroleum products. Because of the shorter length of the deep-water ship channel, compared to the lower Sacramento River, and slack water in the ship channel, much loaded shallow-draft traffic moves up the ship channel, through the connecting channel and lock, and into the Sacramento River. Empty down-bound tows utilize both the river and the ship channel. In addition to shallow-draft facilities at the Port of Sacramento, there are a number of private shallow-draft terminals along the Sacramento River, principally in the vicinity of the city of Sacramento. These include a rice-handling facility with 2 wharves, elevator, warehouse, and storage bins. Downstream of Sacramento there are a number of wharves, some with barge-loading facilities, and one grain elevator. The Sacramento River shallow-draft project is discussed more fully under the Sacramento Basin Subregion.

RECREATIONAL NAVIGATION

The Delta waterways cover approximately 50,000 surface acres and offer one of the most diverse recreational opportunities available to boaters in the United States. During the summer, pleasure boating and waterskiing are the major activities; and fishing for striped bass, salmon, steelhead, sturgeon, shad, catfish and black bass is the major activity in other seasons. Much of the attraction the Delta holds for recreationists is due to the scenic and aesthetic values provided by the riparian environment. The vegetation provides habitat for many wildlife species, and the riparian vegetation is also important to the fisheries resources.

The 1960 recreation use survey of the Delta area, reported in "State Bulletin No. 76, Delta Water Facilities," indicated waterborne recreation use in the Delta was 2,096,000 recreation days out of a total of 2,800,000 recreation days in the area. The number of boat days in the Delta was estimated to be 565,000 for 1960, based on boats berthed at resorts and yacht clubs; boats launched; boats rented; boats berthed at private docks in the Delta, San Francisco Bay area and Sacramento area. The majority of boaters using the Delta channels in 1960 resided in the Delta-Central Sierra and San Francisco Bay subregions.

The 1960 State survey indicated there were 123 private and public resorts in the Delta primarily serving boaters and fishermen; the number has increased significantly since that time. Most facilities in the Delta are privately owned; however, there are a few State recreation areas and boat-launching ramps and county parks. The only Federal recreation development in the Delta was constructed recently as a part of bank stabilization work and includes a 2-lane boat-launching ramp and parking area.

For an analysis of boat-launching facilities in the subregion, annual boating use in boat days was reduced to a design day load equivalent, reflecting average weekend day conditions during peak month of use. (It is estimated that 15 percent of boat use in the Delta occurs during the peak month, with about 60 percent of this use occurring on weekends.) Corps of Engineers design standards were used - 40 launchings per normal weekend day per lane. This differs from State of California design standards of 50 launchings per lane used in determining launching land requirements in the coastal subregions. Launching lanes on the inland waters are characteristically less sophisticated, access to the water is often somewhat difficult, and the high-capacity launching hoists often used in coastal harbors and marinas are not generally warranted. Table DC-5 indicates an excess of launching lanes in 1965; however, this excess may not truly reflect actual conditions because of inadequate parking facilities and improper distribution of lanes.

Quality of boating facilities ranges from makeshift and temporary to elaborate and expensive, and an evaluation of the quality is not available. A survey conducted for the State in 1962 concluded that the boating population using Delta channels was, for the most part, dissatisfied with launching facilities. For weekend and vacation boating trips, users also were dissatisfied with inadequate berthing facilities. The survey indicated that crowded conditions at launching facilities were not a cause for complaint, but many facilities were substandard in construction, design, operation or maintenance.

Future Needs

COMMERCIAL NAVIGATION

General

Estimates of future needs for commercial navigation were assessed in terms of projected waterborne commerce tonnages, considered in terms of commodity classes. The bases for the projections are discussed in the following paragraphs. Present and projected future commerce in the subregion is summarized in Table DC-1 and broken down by commodity class in Table DC-2.

Port of Stockton

Deep-draft Traffic

Detailed studies of historical tonnage movements and future supply and demand factors were made for the "Review Report on Navigation - San Francisco Bay to Stockton, Appendix C," dated November 1963. Subsequent to those studies, the effects of recent developments on future

tonnage movements were examined. In adjusting the projections, consideration was given to tonnage movements in recent years: existing and expected contracts with shippers and the Port of Stockton: and the effect of modernizing and expanding loading and storage facilities. Port improvements will include a container station, additional general cargo warehouse space for LASH barge operation, and major bulk terminal improvements, all of which will increase the capacity of the port. Specific commodities and commodity groups have fluctuated from year to year, so projections were based on a five-year average as a base. The major bulk commodity movement for the port at the present consists of coal, petroleum coke, coke breeze, phosphate rock, sulphur, and clay (iron ore shipments from Stockton to Japan have ceased to be significant). Review of tonnage estimates in connection with port improvements provided a basis for projecting future tonnages of most bulk commodities. Projections of other commodity classifications, such as farm products, canned goods, wine and liquors, molasses, and petroleum products follow, generally, those projections made for the "Review Report," with minor adjustments to reflect recent data. Foreign export of chemical fertilizers is expected to increase substantially and is taken into account in miscellaneous exports.

Shallow-draft Traffic

Estimates of future barge traffic were modified from the "Review Report," principally in the movement of petroleum products. Pipelines have recently made significant inroads in the transport of petroleum products to this service area, but it is not expected that pipelines will completely replace barges in the future for transportation of petroleum products.

Port of Sacramento

Deep-draft Traffic

A review was made of potential tonnages developed in feasibility studies for the ship channel and summarized in Design Memorandum No. 2, dated December 1956. Comparison of these data with actual tonnage movement indicated the projections were not adequate for use in framework studies. Also, since the port began operation in July 1963, the period of record for oceanborne commerce is too short to use published historical trends as a basis for projecting future tonnages. Deep-draft tonnage currently moving exceeds the projection of future tonnages in the feasibility studies. Oceanborne tonnage in 1967 exceeded a million tons, compared to 435,000 in 1965, and 1967 was used as the base year for projections. More than 95 percent of the deep-draft tonnages are foreign exports, and a large part are Pacific bound. The predominant commodities are farm produce and products originating in the Sacramento Basin subregion as well as in the Delta-Central Sierra subregion. Because the world trade situation changes so much, it is difficult to estimate future

demand for foreign exports from a specific port with confidence. However, the following assumptions were made: (1) The Pacific-Asiatic area will continue to be important for United States trade and especially for Pacific Coast ports; (2) The current ratio of exports of rice and grains through the Port of Sacramento to production of rice and grains in the Sacramento Valley will remain fairly constant; (3) Domestic consumption of farm products (other than rice and grains) will increase slightly more than production in the Sacramento trade area, and increases in farm products exports will be slightly lower than increases in production; and (4) Preliminary estimates by the University of California at Davis of future crop production in the Sacramento Basin are adequate. Exports of forestry products (wood chips, lumber, and logs) from Sacramento to the Pacific-Asiatic area have recently become significant and are expected to increase in the future. The projection for 1980 takes this into account; however, the increases thereafter are conservatively estimated; United States Forest Service projections of wood products production in California show a decrease. At this time, foreign imports and coastwise receipts are small compared to outbound traffic. Projections of future inbound traffic were related to population projections; however, since the current base is small, future tonnages are of minor significance. This situation could change if future industries locating in the area required the import of large quantities of raw materials.

Shallow-draft Traffic

Petroleum products have been the most significant items moved by barge to Sacramento; however, pipelines have been replacing barges for these commodities. In 1965 internal receipts of petroleum products were about 1,457,000 tons, but had declined to about 800,000 tons in 1967. It is expected that pipelines will continue to supplant barge transport of petroleum products to this area.

Port of Collinsville

The Collinsville-Montezuma Slough area is adjacent to the Sacramento Deep-Water Ship Channel and has rail service and flat land. The San Francisco Bay Plan, developed by the San Francisco Bay Conservation and Development Commission, indicates that roughly 32 percent of the total projected additional water-oriented industrial acreage needed in the Bay area is in the Collinsville area. Several large tracts of land, in the thousands of acres, are in single ownerships and are planned for industrial use at the present time. Very preliminary investigations indicate that traffic at a port complex in this area would be in excess of 3 million tons annually. Primary commodities would be bulk ores imported for the proposed steel facility.

RECREATIONAL NAVIGATION

General

Future needs for recreational navigation were assessed in terms of launching facilities and berthing facilities, and are summarized in Table DC-4. Projections of these needs were based on population projections for the service area (California Base Plan) and projections of boat ownership and use. Water-oriented recreation use in the Sacramento-San Joaquin Delta originates primarily in Sacramento, San Joaquin, Contra Costa, Solano, and Alameda Counties. Data on vessel size in the "California Small Craft Harbor and Facilities Plan," dated March 1964, indicate a significant trend to larger boats in recent years, and this trend is expected to continue. In the future a larger percentage of those boats not moored or docked will be launched from ramps, and fewer will be launched by hand.

Trends in Boat Ownership

Boat registration in California since 1960 has increased much more rapidly than the increase in population. Boat ownership per thousand population for counties in the recreation demand area for the Delta-Central Sierra Subregion is higher than for the State as a whole and is summarized in the following tabulation.

County	Number of boats per thousand population		
	December 1960	December 1965	December 1967
Alameda	12.0	18.7	21.7
Contra Costa	31.1	31.7	35.9
Sacramento	26.1	32.5	38.1
San Joaquin	23.5	30:1	36.5
Solano	28.2	31.7	34.3
Market area average	24.2	28.9	33.3
State-wide average	14.3	18.3	21.5

It appears that past predictions of boat ownership will be greatly exceeded.

Trends in Boat Storage

Boat storage is of two types: (1) Boats kept in dry storage and launched each time they are used; and (2) boats kept in the water in berths or moorings. There are two long-range trends that affect the percentage of boats launched versus boats moored. The size of boats is increasing, and a higher percentage of boats will be moored in the

future, due to the greater difficulty of trailering larger boats. However, there is a counter-balancing trend toward crowding of existing marinas in the narrow, twisting waterways in the Delta and increasing costs for mooring boats in these areas. While no specific studies were conducted to evaluate these factors, observation and informal discussion indicate a growing concern over the lack of free movement on crowded waterways from a single mooring location and over the rapidly increasing cost of boat mooring. It is estimated that the percentage relationship between moored and launched boats will remain approximately the same to year 2020.

Trends in Boat Use

The 1960 boating survey for State Bulletin No. 76 indicated average annual use in the Delta is 53.7 boat days per boat. This high number of boat days is due to the diverse activities that can be pursued in the area throughout the entire year. In projecting future boating use, the number of boat days per boat was held constant and the number of boats projected, based on population projections, per capita boat ownership projections, and water zoning. Estimates of 1965 boat use and projections of future use are summarized in the following tabulation.

Recreation days reflects average boating party size.

Year	Boat days	Recreation days
1965	710,000	2,840,000
1980	1,250,000	5,000,000
2000	2,100,000	8,400,000
2020	2,800,000	11,200,000

Means to Satisfy Future Needs

COMMERCIAL NAVIGATION

General

Means to satisfy future needs for commercial navigation in the Delta-Central Sierra subregion are estimated to include enlarging existing channels to the deep-draft ports at Stockton and Sacramento and expanding facilities at these ports and, in addition, deepening the channel in the eastern reach of Suisun Bay for development of a port complex in the Collinsville area. Existing and projected deep-draft commercial navigation features are summarized in Table DC-3. Shallow-draft facilities are considered adequate for present and future traffic.

Means to satisfy future needs are defined in terms of projected required navigation features and terminal facilities. Projected navigation features were based on design vessels of the dry bulk carrier class, in accordance with traffic predictions, and on the assumption that the present trend to larger dry bulk carriers will continue. The latter assumption is supported by data presented in "Harbor and Port Development," dated July 1968. That report indicated that in 1965 dry bulk carriers of 30,000 deadweight tons (dwt) and larger represented about 30 percent of the world fleet's dry bulk tonnage capacity, and that this percentage increased to approximately 40 percent in 1966; that dry bulk vessels delivered in 1967 averaged 41,600 dwt: that those on order in 1967 included 100 carriers exceeding 60,000 dwt; and that in early 1968, the average size of 423 bulk carriers on order was 39,800 dwt. The selected design vessel for the Port of Stockton and the Port of Sacramento was a 50,000-ton vessel with loaded draft in the order of 35 to 38 feet. The design vessel for the projected facility at Collinsville in 1980 was a 70,000-ton dry bulk carrier with the channel forecast to provide for a 100,000-ton carrier by 2020.

Port of Stockton

Improvements to the San Joaquin River and Stockton Channel, authorized by the 1965 Rivers and Harbors Act, provide for deepening the present channel to 35 feet, making it feasible for vessels of up to 40,000-ton cargo capacity to call at the port. Construction of this project, a part of the over-all improvement from the San Francisco Bar to Stockton, has not yet been funded, and it is estimated that probably it will not be completed until about 1980. It is estimated, on the basis of very preliminary data, that this improvement probably will be adequate until about the year 2000, by which time the larger bulk carriers expected to be in operation probably would make it feasible to provide additional depth to the Port of Stockton. However, deepening the channel beyond the 35-foot depth presently authorized will be very costly and will require major modifications of levees protecting the numerous reclaimed tracts in the Sacramento-San Joaquin Delta. These levees are founded on peat, and levee relocation, reconstruction, and stabilization are expensive projects which must be carried out over a period of several years.

Commodities projected to move through the Port of Stockton include dry bulk, liquid bulk, general cargo, and container cargo. New facilities and modernized and expanded facilities needed to handle the projected commerce include the following:

(1) Modernize and upgrade loading facilities at the 2 bulk ore berths.

(2) Construct a LASH terminal. A LASH-type operation is scheduled to be initiated in the San Francisco Bay area in 1970. This operation

involves a high-speed "mother" ship transporting individual steel lighters, each capable of handling 415 short tons. The mother ship would not move beyond San Francisco Bay in Northern California and would discharge lighters to be ferried to outlying ports, including Stockton. High-speed turn-around of these lighters is mandatory and will require special terminal facilities for rapid unloading in inclement weather.

(3) Construct a complete container station. The port has plans for the immediate future to renovate and improve one berth for a container station and to equip it with efficient dockside railroad and crane facilities and a marshalling yard. The number of berths is forecast to increase from the present 15 to 20 by 2000, with a corresponding increase in backup cargo handling area from 230 to 300 acres.

Port of Sacramento

Preliminary evaluations indicate that increased traffic at the Port of Sacramento probably will justify deepening the channel to 40 feet in two increments in the future. The port owns ample waterside frontage to increase the number of berths from the present 5 to 20 to handle the forecast future tonnage and also adequate backup land for cargo handling. No unusual problems are anticipated in enlarging the channel in the future. Provision of a turning basin approximately 10 miles downstream from the port on the deep-water ship channel would stimulate industrial development along the ship channel and contribute to future port traffic.

To handle the forecast increased tonnage, the port will require greatly expanded cargo handling equipment for bulk rice and grain; for wood products; for general cargo, including container handling facilities; and probably a LASH station.

Port of Collinsville

Industrial development projected for the Collinsville area would center around a proposed integrated steel mill and fabricating plant. Port facilities would be required for handling general cargo exports, but primarily cargo would be imported bulk raw material for the steel mill. Very preliminary investigations indicate it might be feasible to deepen the channel to 45 feet by 1980, after the 45 foot authorized channel through Suisun Bay is completed as a part of the over-all San Francisco Bay to Stockton project. There appears to be adequate deep-water frontage at Collinsville to accommodate the number of berths required, and additional deep-draft or shallow-draft frontage could be developed along the east side of Montezuma Slough.

RECREATIONAL NAVIGATION

Future needs for recreational boating in the subregion can be satisfied by construction of additional launching and berthing facilities in the Delta area. The number of boat-launching facilities needed to satisfy estimated future boating use was based on Corps of Engineers standards, as previously discussed. Estimated future needs for launching and berthing facilities and deficiencies are shown in Tables DC-4 and DC-5, respectively. In 1965 public boat launching ramps in the Delta were limited to sites along the Sacramento River, at Stockton on the San Joaquin River, and at Brannan Island State Recreation area. These public facilities represented in the order of 10 percent of all launching facilities available in the subregion. Additional launching ramps were available at approximately 50 percent of all private marinas, harbors, and similar developments with berthing facilities on major and minor streams throughout the Delta area. It is anticipated that additional water-oriented recreational facilities, primarily launching ramps and associated sanitary facilities and parking areas, will be provided in the future in the Delta in conjunction with Federal flood control, navigation and bank stabilization projects, particularly at the presently undeveloped Franks Tract State Recreation Area, and in conjunction with the proposed Peripheral Canal. Facilities for berthed boats in the Delta area traditionally have been supplied by private developers, and this practice is expected to continue in the future. Most levees protecting agricultural tracts in the Delta were originally constructed by private interests, and the Federal Government has no jurisdiction over the operation and maintenance of these private levees. Many are adjacent to the channels, forming the stream banks, and are vulnerable to damage from recreational navigation wavewash. In recent years, with increasing use of the Delta by recreationists, problems of preserving the scenic, conservation, and recreation values of the area while meeting navigation needs and providing adequate flood protection have become more urgent and complex. These problems have not yet been resolved.

Data in Table DC-5 indicate that the total number of launching lanes forecast for 1980 exceeds the number of launching lanes needed; however, many existing privately owned ramps are substandard or have inadequate parking and cannot provide 40 launchings per day. Also, a number of small marina operators have boat-launching ramps to provide a balance of facilities. Distribution of such ramps is not ideal with respect to maximizing use, and some are not utilized to full capacity. The Delta-Central Sierra subregion is projected to have a deficiency of approximately 5,700 berthing spaces by 1980, assuming all spaces presently planned are built, and an increasing deficiency is projected to year 2020. For private enterprise to justify investment in additional facilities, construction of such facilities is projected to continue to lag behind demand.

Implementation

Implementation of development of the commercial navigation facilities for the Delta-Central Sierra subregion described in the foregoing paragraphs would require about 100 million cubic yards of dredging and construction, or reconstruction, of approximately 15 miles of levees between the years 1966 and 2020. Estimated quantities by period are as follows:

Item	Unit	1966-1980	1981-2000	2001-2020
Dredging navigation features (Federal)	Cu. yds.	33,000,000	37,000,000	26,000,000
Levees (Federal)	Miles	7	8	0

Channels in the subregion are adequate for recreational use, and no channel improvements for recreational navigation are projected. Recreational developments in conjunction with Federal and State multiple-purpose projects are projected to include launching ramps, access, parking areas, and sanitary facilities. Berthing facilities are projected to continue to be supplied by private investment, and for purposes of this study were estimated to cost $1,000 per berth.

Maintenance of the commercial navigation features would include maintenance dredging of the channels and other water areas and maintenance of protective works. It is estimated that average annual maintenance dredging quantities would be as follows:

Year	Dredging in cubic yards
1965	1,100,000
1980	1,100,000
2000	1,400,000
2020	1,600,000

Order-of-magnitude estimates of first costs and annual costs for operation and maintenance of the navigation features were based upon historical cost trends, costs for existing navigation projects, and average unit costs for dredging. Costs were assigned to Federal and non-Federal interests in accordance with current practice. Costs of commercial navigation features, including channels, turning basins, and anchorage areas, would be 100 percent Federal, and costs of operation and maintenance of potential Federal navigation projects would be Federal. Costs of construction of potential project-associated recreational developments would be 50 percent Federal and 50 percent non-Federal, and costs of operation and maintenance of these facilities would be borne by local interests. Berthing facilities are projected to be provided by private

development , and no operation and maintenance costs have been projected for these facilities. Estimated costs of navigation features for the subregion are summarized as follows:

Summary of first costs

Feature	1966-1980	1981-2000	2001-2020
Commercial navigation			
Federal	$21,400,000	$23,300,000	$18,000,000
Non-Federal	25,400,000	17,400,000	14,100,000
Recreational navigation			
Federal	500,000	4,000,000	500,000
Non-Federal	7,800,000	17,000,000	12,500,000

Summary of annual maintenance costs

Feature	1966-1980	1981-2000	2001-2020
Commercial navigation			
Federal	$800,000	$1,000,000	$1,100,000
Recreational navigation			
Non-Federal	50,000	450,000	450,000

DELTA-CENTRAL SIERRA SUBREGION

TABLE DC-1

Summary of Waterborne Commerce[1/], 1965-2020

Type of Commerce	1965[2/]	1980	2000	2020
Foreign exports	1,997	3,520	3,950	4,090
Foreign imports	227	280	400	540
Coastwise shipments	81	350	420	480
Coastwise receipts	170	360	490	740
Internal shipments	19	170	240	270
Internal receipts	2,360	1,750	2,320	3,980
Total commerce	4,854	6,430	7,820	10,100

1/ Thousands of short tons.

2/ From "Waterborne Commerce of the United States, Part 4", Department of the Army, Corps of Engineers.

DELTA-CENTRAL SIERRA SUBREGION

TABLE DC-2

Delta-Central Sierra Ports, 1965 Waterborne Commerce[1/], and Projected Waterborne Commerce 1980-2020

Commodity Group	1965[2/]	1980	2000	2020
Foreign exports				
Metallic ores, non-metallic minerals	901	1,340	1,510	1,410
Farm products	853	1,500	1,660	1,830
Food and kindred products	109	40	50	50
Lumber and wood products	6	240	260	280
Miscellaneous	128	400	470	520
Subtotal, exports	1,997	3,520	3,950	4,090
Foreign imports				
Food and kindred products	70	110	170	220
Miscellaneous	157	170	230	320
Subtotal, imports	227	280	400	540
Coastwise shipments				
Food and kindred products	62	280	340	380
Miscellaneous	19	70	80	100
Subtotal, shipments	81	350	420	480
Coastwise receipts				
Petroleum products	169	250	340	520
Miscellaneous	1	110	150	220
Subtotal, receipts	170	360	490	740
Total, ocean commerce	2,475	4,510	5,260	5,850

See footnotes at end of table.

Continued.

DELTA-CENTRAL SIERRA SUBREGION

TABLE DC-2

Delta-Central Sierra Ports, 1965 Waterborne Commerce[1/], and Projected Waterborne Commerce 1980-2020 (Cont.)

Commodity Group	1965[2/]	1980	2000	2020
Internal shipments[3/]				
Farm products	15	120	180	180
Miscellaneous	4	50	60	90
Subtotal, shipments	19	170	240	270
Internal receipts				
Petroleum products	2,163	1,510	1,910	3,360
Food and kindred products	76	80	120	150
Miscellaneous	121	160	290	470
Subtotal, receipts	2,360	1,750	2,320	3,980
Total, internal commerce	2,379	1,920	2,560	4,250
Total commerce	4,854	6,430	7,820	10,100

1/ Thousands of short tons.

2/ From "Waterborne Commerce of the United States, Part 4", Department of the Army, Corps of Engineers

3/ Excludes projections of aggregate shipments for use in greater Bay Area.

DELTA-CENTRAL SIERRA SUBREGION

TABLE DC-3

Existing and Projected Commercial Navigation Features and Terminal Facilities

	1965	1980	2000	2020
Navigation features:				
Channel:				
Depth, feet	10-30	10-45	10-45	10-45
Width, feet	200-225	200-300	200-300	200-400
Length, miles	144	147	147	147
Turning basins:				
Depth, feet	30	35-45	40-45	40-45
Area, acres	137	237	250	250
Terminal facilities:				
Berths, number	20	27	37	43
Cargo-handling area, acres	290	380	510	580

DELTA-CENTRAL SIERRA SUBREGION

TABLE DC-4

Recreational Navigation Needs, 1965-2020

	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	1/	1/	1/	1/
Subregion population, thousands	386	530	985	1,981
Number of berths needed	11,300	20,700	35,600	49,300
Trailered boats				
Number of trailered boats using navigable waters	4,800	8,600	15,000	21,000
Number of peak-day launchings	3,500	6,200	11,200	15,500
Launching facilities needed 2/	70	120	215	300

1/ Not applicable since recreation tributary area includes population from Alameda, Contra Costa, Sacramento, San Joaquin and Solano Counties not within Delta-Central Subregion.

2/ Launching lanes 12 feet wide or hoists with launching capacity of 40 boats per peak day.

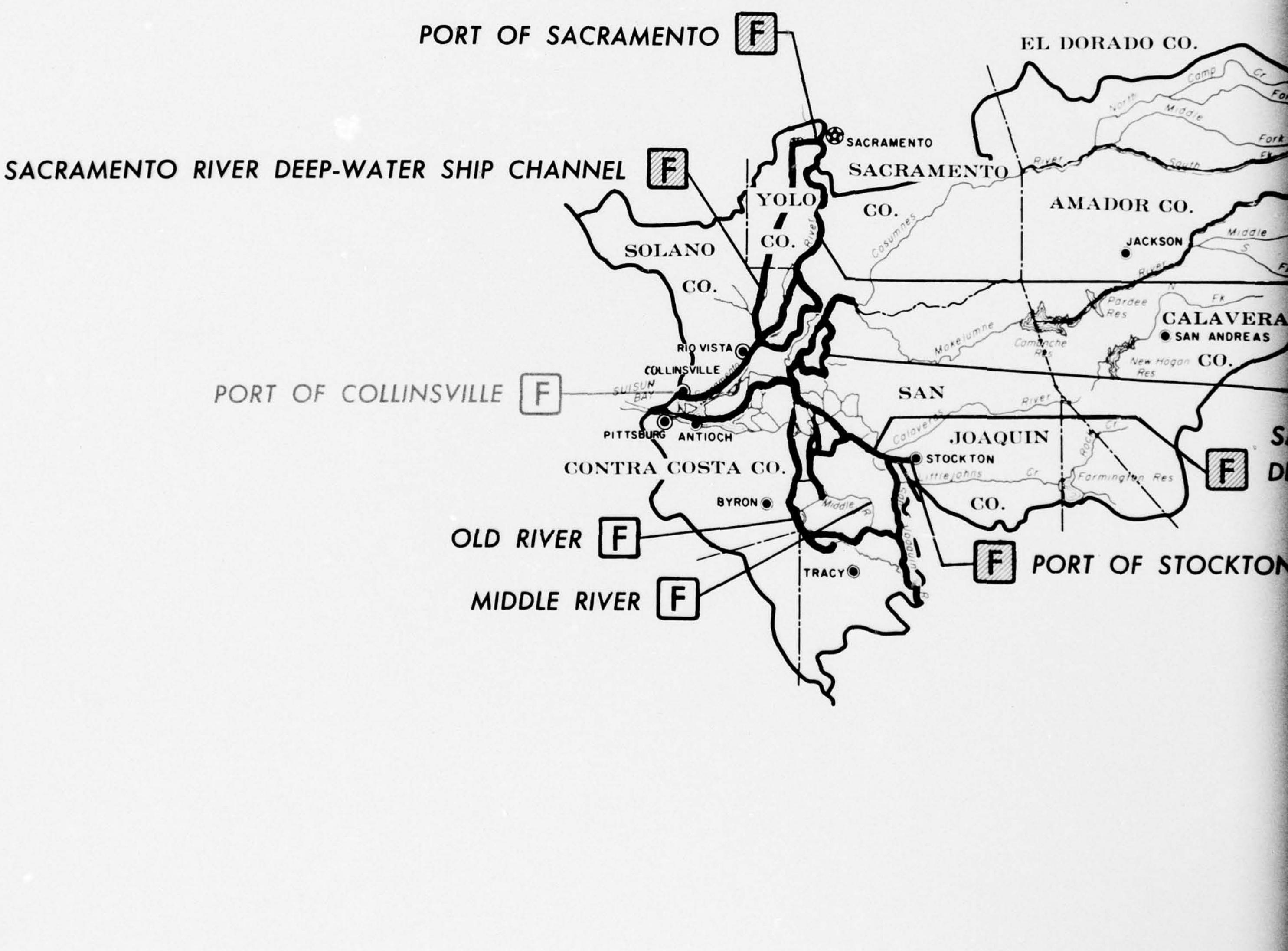
DELTA-CENTRAL SIERRA SUBREGION

TABLE DC-5

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	11,300	9,400	20,700	14,900	35,600	13,700	49,300
Needs met:							
Within facilities existing in 1965	7,700	0	7,700	0	7,700	0	7,700
Within facilities definitely programmed in 1965	0	0	0	0	0	0	0
Within projected facilities not programmed in 1965	0	7,300	7,300	13,000	20,300	12,000	32,300
Incremental additions		7,300		13,000		12,000	
TOTAL	7,700		15,000		28,000		40,000
Residual un-met needs	3,600		5,700		7,600		9,300
Launching lanes							
Needs	70	50	120	95	215	85	300
Needs met:							
By lanes existing in 1965	120	0	120	0	120	0	120
By projected lanes	0	45	45	15	60	70	130
Incremental additions		45		15		70	
TOTAL	120		165		180		250
Residual un-met needs	0		0		35		50
Transient moorings 1/							

1/ Not applicable in this subregion.


PORT OF SACRAMENTO
SACRAMENTO RIVER DEEP-WATER SHIP CHANNEL
PORT OF COLLINSVILLE
OLD RIVER
MIDDLE RIVER
PORT OF STOCKTON
EL DORADO CO.
SACRAMENTO
SACRAMENTO
CO.
YOLO
CO.
AMADOR CO.
JACKSON
SOLANO
CO.
RIO VISTA
COLLINSVILLE
SUISUN BAY
PITTSBURG
ANTIOCH
CALAVERAS
SAN ANDREAS
CO.
SAN
JOAQUIN
CO.
STOCKTON
CONTRA COSTA CO.
BYRON
TRACY
Cosumnes
Mokelumne
Camanche Res
Pardee Res
New Hogan Res
Calaveras
Farmington Res
Middle

1
2

LEGEND

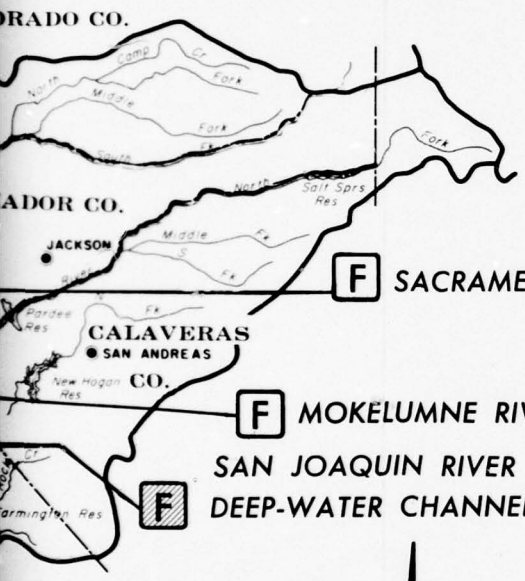
EXISTING DEVELOPMENT (1965)

[F] Federal projects

POTENTIAL DEVELOPMENT

[F] Future Federal project, not programmed

Existing harbor requiring expansion, not programmed



[F] *SACRAMENTO RIVER SHALLOW DRAFT CHANNEL*

[F] *MOKELUMNE RIVER*

SAN JOAQUIN RIVER AND STOCKTON DEEP-WATER CHANNEL

[F]

T OF STOCKTON

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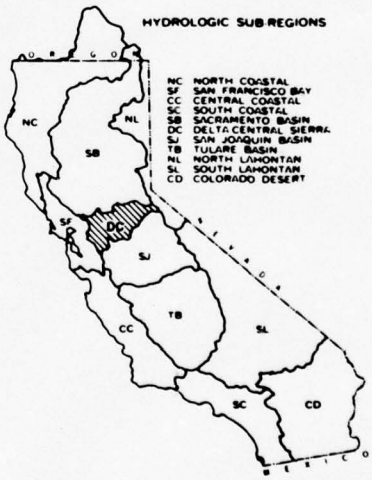


MAP DC-1

DELTA-CENTRAL SIERRA SUBREGION

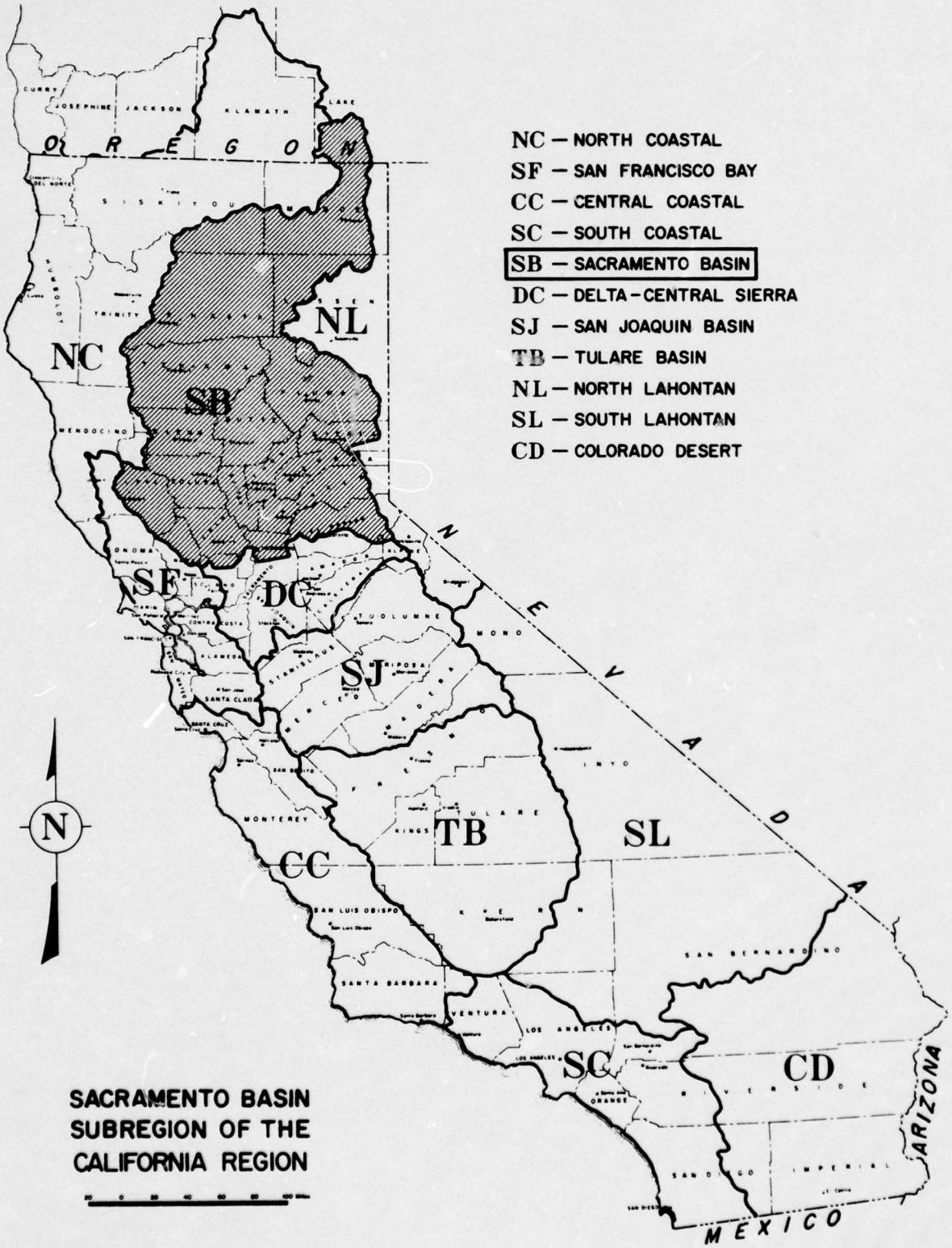
CALIFORNIA REGION

COMMERCIAL NAVIGATION DEVELOPMENT

10 0 10 20

SCALE IN MILES

SACRAMENTO BASIN SUBREGION



SACRAMENTO BASIN
SUBREGION OF THE
CALIFORNIA REGION

SACRAMENTO BASIN SUBREGION

General

The Sacramento Basin subregion is situated in north and north-central California and covers approximately the northern half of the Central Valley. It is bounded by the Sierra Nevada Range on the east, the Coast Range on the west, the Cascade Range and Trinity Mountains on the north, and the northern border of the Delta-Central Sierra subregion near the city of Sacramento on the south. The subregion is described in detail in Appendix II. The only portion of the subregion of importance to channel navigation is the Sacramento River below Red Bluff and the lower reaches of the Feather and American Rivers. See Map SB-1.

Agriculture is the dominant economic activity in the subregion and includes both crop and livestock production. Crop production shows a high degree of diversification, including grain, rice, field crops, deciduous and citrus fruits, nuts, vines, and truck crops. Important economic functions subsidiary to agriculture include the packing and processing industry, the agricultural-service industry, and the farm equipment industry. The production of natural gas, clay, limestone, sand and gravel, and lumber and other forest products; recreation; government; and aerospace employment are also significant economic activities in the subregion.

Existing Development

COMMERCIAL NAVIGATION

Sacramento River Shallow-Draft Channel

The Sacramento River has served as an artery for waterborne commerce since the earliest days of settlement in the Central Valley. The original Sacramento River Shallow-Draft Channel project was adopted by the River and Harbor Act of 1875, and modified by Acts of 1882, 1889, and 1894. The existing shallow-draft improvements were authorized by the River and Harbor Act of 1899 and modified by Acts of 1912, 1927, and 1935. The original project provided for improvement of the low-water channels in the Sacramento River and for snagging and construction of temporary wing dams in the Feather River. Modifications to this project provided for dredging the Sacramento and Feather Rivers; for low-flow augmentation in the Sacramento River by operation of Shasta Reservoir; for restraining barriers for hydraulic mining debris in the Yuba, Bear, and American Rivers as an aid to navigation; for improving navigation by repairing damages caused by floods; for snagging above Sacramento; and for removal of obstructions in the lower Sacramento River. The Sacramento River Shallow Draft Project is deficient in

depths during low-flow periods. The authorizing document for Shasta Dam included provision of minimum releases of 4,000 cubic feet per second to maintain navigable depth; however, releases for other project purposes generally meet this minimum flow requirement.

The existing project provides for a channel 10 feet deep at mean lower low water, 150- to 200-foot bottom width, from Suisun Bay to Sacramento (in the Delta-Central Sierra subregion), a distance of 60 miles; a depth of 6 feet at low water between Sacramento and Colusa, a distance of 85 miles; a depth of 5 feet at low water between Colusa and Chico Landing, a distance of 50 miles; and such depths as practicable between Chico Landing and Red Bluff, a distance of 53 miles. The 10-foot channel to Sacramento was completed in 1931, and the 6-foot channel to Colusa has been completed. No work has been done in the Colusa to Chico Landing reach because of lack of traffic. The Sacramento River channel is navigable during the entire year; however, there is no regular commercial navigation upstream of Colusa. A barge canal with navigation lock 86 feet wide by 600 feet long, with 13-foot minimum depth, connects the Sacramento Deep-Water Ship Channel and the Port of Sacramento (in the Delta-Central Sierra Subregion) with the Sacramento River at the city of Sacramento. The navigation lock requires, on the average, about 25 acre-feet of water per lockage. Full requirements for lockage water would be more than covered by water requirements for other purposes below the junction of Cache Creek with the Sacramento River. Much of the present barge traffic below Sacramento, to and from the San Francisco Bay area, uses the deep-water channel due to the shorter distance, slack water, and generally better navigation conditions than in the Sacramento River.

A relatively small volume of barge traffic currently moves on the Sacramento River upstream of the city of Sacramento, compared to the vast amounts of agricultural production in the basin and export of these commodities from the area. This is due to a combination of factors. The use of river transportation involves a short truck haul to a river terminal, storage, barge loading, and transport to Sacramento or Bay area ports. Distances are short, and the total cost per ton-mile from farm to destination and the time to complete the haul, compared to other modes of transport, are deterrents to use of river navigation. Some advantage in water transportation can be found for certain farm commodities, such as rice and grains, that can be stored for long periods. Historical shallow-draft traffic on the Sacramento River above Sacramento is summarized in the following tabulation. These data indicate that comparatively large tonnages of petroleum products were transported until about 1960. With completion of a petroleum pipeline from Sacramento to Chico Landing, movement of this commodity was reduced significantly by 1965, and future projections of petroleum traffic are nominal. Non-metallic minerals originate from the San Francisco Bay area and consist principally of riprap and sand and gravel for bank protection work.

Traffic in 1,000 tons

Commodity group	1955		1960		1965	
	Up-bound	Down-bound	Up-bound	Down-bound	Up-bound	Down-bound
Petroleum products	163	-	120	-	36	-
Nonmetallic minerals	104	-	73	-	29	-
Miscellaneous (including farm products)	-	21	-	12	-	28
Total	267	21	193	12	65	28

Between Sacramento and Colusa, there are 10 large warehouses and a number of small landings. Present indications are that the existing channel to Colusa is adequate for existing traffic.

Feather River Channel

Prior to 1917, there was no Federal navigation project on the Feather River, although local interests had done considerable work in improving the channel and providing terminal facilities: and minor work had been done from Federal appropriations under "Sacramento and Feather Rivers." Improvement of the Feather River for navigation was originally adopted by the River and Harbor Act of 1916. The adopted plan provided for a channel of 2.5 foot-depth at low water from the mouth of the river, near Verona, to the head of navigation at Marysville, a distance of about 28 miles. The existing project was authorized by the River and Harbor Act of 1927 and is a program of maintenance, consisting of the removal of obstructions and construction of wing dams, as necessary, between Verona and Marysville to provide for a channel of such depth as may be practicable. Channel maintenance work was initated in 1928 and was continued through 1948; no work has been accomplished since that time. At the present time there is no commercial traffic on the Feather River.

RECREATIONAL NAVIGATION

Primary navigable streams used for recreational boating in the Sacramento Basin subregion are the Sacramento River from the city of Sacramento upstream to the Red Bluff Diversion Dam (183 miles); the Feather River upstream to its confluence with the Yuba River (27 miles); and the lower 10 miles of the American River. The Sacramento Basin subregion has less waterway area and is of less importance to regional water-oriented recreation than is the Delta-Central Sierra subregion

immediately to the south. However, streams in the Sacramento Basin subregion have an unusual recreational boating potential, being connected with and contiguous to the San Francisco Bay and San Joaquin River areas. It is estimated that only a small percent of total boat days in the subregion is spent on navigable waterways, most of the boating use being on lakes in the area.

Recreation boaters use the navigable waterways of the subregion for water-oriented sports; and for fishing in the Sacramento, Feather, and American Rivers throughout the year. With the rapidly growing urban population in the recreation market demand area, there is need for additional water-oriented recreational opportunities that can be provided by the inter-connected San Francisco Bay-Sacramento-San Joaquin system.

No detailed studies of recreation-use or boater-use have been made for this subregion. Most boating use originates within the subregion, in the counties of Sacramento, Yolo, Sutter, Yuba, Colusa, Butte, Glenn, and Tehama; however, some use, particularly on the American River, originates in the adjoining Delta-Central Sierra subregion.

The current need for small-craft berthing facilities is being met largely by private development, with marinas located along the riverbanks or in small excavated harbors. Because the Sacramento, Feather, and American Rivers carry large floodflows, boating on these streams is extremely dangerous during the winter and spring flood periods, and marina developments are subject to heavy damage during such times. It is estimated that approximately 50 percent of the boating use on waterways in the subregion is attributable to launched boats. Launching ramps have been provided on the river banks by the State and local agencies and by owners of private marinas to provide a balance of facilities, even though such ramps are not fully utilized. Table SB-3 indicates a surplus of launching lanes in 1965; however, some lanes are inadequate or not optimally distributed, so that a deficiency actually exists in some areas. The quality of berthing and launching facilities varies widely.

Future Needs

COMMERCIAL NAVIGATION

General

Estimates of future needs for shallow-draft commercial navigation in the Sacramento Basin Subregion were assessed in terms of projected waterborne commerce tonnages, considered in terms of commodity classes. Estimates were based on preliminary economic studies for the current

investigation of navigation improvements in the Sacramento Valley and are summarized in the following paragraph. Forecasts do not indicate that a need will develop for commercial navigation on the American River.

Sacramento River

For the Sacramento River above the mouth of the Feather River, studies indicated that, with an improved channel, waterborne shipments would increase from approximately 93,000 tons in 1965 to about 1,000,000 tons. The increased traffic would be primarily agricultural products. However, this increased commerce would not be sufficient to justify deepening the present channel from Verona to Colusa or extending the channel upstream from Colusa. It is expected that future releases from additional storage projects and transfer of water imported from other drainage basins will increase flows in the Sacramento River to well above the minimum required to maintain the authorized depths. In recent years there has been little commercial navigation upstream of Sacramento, and projections of future traffic do not indicate that additional storage or releases to maintain navigable depths would be warranted. Rather, it might be necessary to curtail depths for short periods of critical low flow in the future until additional upstream storage units for conservation purposes are completed.

Feather River

Studies of potential new traffic in the Sacramento Valley indicated that aggregates in the San Francisco Bay area will be in short supply in the future and that a promising new source of supply would be deposits along the Feather River near Nicolaus and the lower Yuba River. Preliminary evaluations indicate that when the need for these aggregates develops, it will be feasible to provide a channel of approximately 12-foot depth for water transport to the Bay area. Aggregate shipments could be in the range of 20 to 30 million tons annually. Construction of a Feather River channel could be justified by aggregate traffic, but with the channel improved, water movement of such agricultural products as rice, grains, and sugar beets would increase substantially.

The Sacramento River system, including the Feather River, is of major importance to the California anadromous fishery. Fishery interests, therefore, are opposed to canalization of these streams by locks and dams. It appears that a 12-foot channel could be maintained in the Sacramento River from Sacramento to the mouth of the Feather River by dredging and spur dikes. However, a lock and dam would be required at the mouth of the Feather River to provide 12 feet of depth in the Feather River. Water requirements for lockage would be minor and could be easily met by releases for other purposes. As an alternative, consideration is being given to a canal route from the mouth of the

Feather River upstream to Nicolaus and to the vicinity of Marysville. If a commercial channel to the Marysville area is constructed in the future, it is projected that by that time releases for conservation purposes would be adequate to maintain navigable depths in the Sacramento River downstream of the mouth of the Feather River and that additional storage to augment releases for navigation would not be required.

RECREATIONAL NAVIGATION

Future needs for recreational navigation were assessed in terms of launching facilities and berthing facilities, and are summarized in Table SB-2. Projections of these needs were based on population projections (California Base Plan) and projections of boat ownership and use. The Sacramento River above Colusa and the lower reaches of the Feather and American Rivers are presently navigable by some recreational craft. Increased depth in these channels would permit use by larger craft and would provide safer navigation by all craft.

Boat ownership in the subregion has increased rapidly in recent years, as indicated by the following data, tabulated by counties in the recreation use area.

County	Number of boats per thousand population		
	December 1960	December 1965	December 1967
Butte	24.9	40.2	52.0
Colusa	44.1	51.9	55.8
Glenn	28.3	38.6	47.8
Sacramento	26.1	32.5	38.1
Sutter	33.8	45.9	54.6
Tehama	32.6	44.8	55.5
Yolo	27.0	34.8	38.2
Yuba	20.9	35.7	38.7
Market area average	29.7	40.5	47.6
State-wide average	14.3	18.3	21.5

The above tabulation indicates boat ownership in the subregion is now more than twice the State-wide average. However, the large number of lakes and reservoirs in the subregion makes boating in navigable rivers a secondary choice, except during fishing runs of salmon and striped bass.

Available data indicate the average size of boats is increasing and, because of the greater difficulty in trailering and launching larger boats, a larger proportion of boats can be expected to be berthed in the future. However, potential damage to berthed boats during flood periods, even in sheltered harbors, is expected to act as a deterrent to a major increase in the proportion of permanently berthed boats. Table SB-2 indicates there will be a growing need for berthing spaces and launching facilities in the subregion. Estimates of 1965 boat use and projections of future use are as follows:

Year	Boat days	Recreation days
1965	40,000	160,000
1980	55,000	225,000
2000	90,000	360,000
2020	140,000	560,000

Recreation days reflects average party size.

Preliminary evaluations indicate that improvement of the Sacramento River channel upstream of Colusa, or annual snagging, for recreational boating probably would not be economically feasible in the period ending in 2020. The channel downstream from Colusa is adequate for small-craft use.

If a project for commercial navigation is found feasible for the Feather River, project-related facilities for recreation boating, including launching ramps and related appurtenances probably would be feasible.

Preliminary studies of the American River indicate that approximately 3 feet of depth prevails in the lower reach at the present time under conditions of average streamflow and that the channel is presently adequate for recreational boating.

Means to Satisy Future Needs

COMMERCIAL NAVIGATION

Means to satisfy future needs for shallow-draft commercial navigation in the Sacramento Basin subregion to year 2020 are estimated to be limited to providing a channel of approximately 12-foot depth from the city of Sacramento to the vicinity of Nicolaus and Marysville along the Feather River and development of a port complex at the two latter areas. The channel probably would be constructed in two segments, initially to the Nicolaus area, when there is a demand for aggregates from that source, and ultimately extended to the vicinity of Marysville when need develops for the Yuba River aggregates. It is roughly estimated that need for the initial segment of the channel probably would develop

by 1985, with the need for channel extension to Marysville by year 2000. Projected commercial navigation features are summarized in Table SB-1.

Project design would be based on traffic by barges and tows. Because shallow-draft technology is changing so rapidly at the present, the specific design craft is subject to change as studies continue.

Commodities expected to move on the waterway are predominately aggregates, with agricultural products totaling approximately 200,000 tons per year. In addition to terminal facilities for handling the aggregate traffic, public terminals and transfer facilities for other cargo would be provided at both Nicolaus and Marysville.

RECREATIONAL NAVIGATION

The number of recreational facilities needed to satisfy estimated future boating use is shown in Table SB-2. The number of boat-launching facilities needed was based on Corps of Engineers standards. Facilities for berthed boats and dry storage and boat-launching ramps traditionally have been supplied by private development in this subregion, and this is expected to continue. It is anticipated that additional water-oriented recreational facilities, primarily launching ramps and associated parking areas, will be provided in the future in conjunction with Federal navigation and bank stabilization projects.

Data in Table SB-3 indicate an excess of launching ramps through year 2000; however, many of the existing ramps are substandard, are not ideally located, or are under-utilized. It is expected that most of the existing ramps will be improved and maintained in an adequate condition; however, some of the existing ramps will probably become obsolete after 1980. Berthing facilities and dry storage spaces are expected to continue to lag somewhat behind need to justify provision of such facilities by private investment.

Implementation

Implementation of development of the commercial navigation facilities for the Sacramento Basin subregion described in the preceding paragraphs would require about 21 million cubic yards of dredging and construction of approximately 20 miles of levees between the years 1981 and 2000 if a canal route is followed upstream of the mouth of the Feather River. Estimated quantities by period are as follows:

Item	Unit	1966-1980	1981-2000	2001-2020
Dredging navigation features (Federal)	Cu. yds.	0	21,000,000	0
Levees (Federal)	Miles	0	20	0

If a commercial navigation channel to the vicinity of Nicolaus and Marysville is constructed, it is probable that project-related features for water-oriented recreation would be included. Additional water-oriented recreational facilities might be developed in conjunction with Federal programs of bank stabilization and channel improvement for flood control.

Maintenance of the commercial navigation features would include maintenance dredging of the channels and other water areas. Maintenance dredging quantities are estimated to be as follows:

Year	Dredging in cubic yards
1965	350,000
1980	350,000
2000	650,000
2020	800,000

Order-of-magnitude estimates of first costs and annual costs for operation and maintenance of the navigation features were based upon historical cost trends, costs for existing navigation projects, and average unit costs for dredging. Costs were assigned to Federal and non-Federal interests in accordance with current practice. Costs of commercial navigation features, including channels and turning basins, would be 100 percent Federal, and costs of operation and maintenance of potential Federal navigation projects would be Federal. Costs of potential project-associated recreational developments would be 50 percent Federal and 50 percent non-Federal, and costs of operation and maintenance of these facilities would be borne by local interests. Berthing facilities and some launching ramps are projected to be provided by private investment, at an estimated cost of $1,000 per berth and about $10,000 per 2-lane launching ramp. No maintenance costs have been projected for facilities provided by private investment. Estimated first costs for navigation features for the subregion would be as follows:

Summary of first costs

Feature	1966-1980	1981-2000	2001-2020
Commercial navigation			
Federal	0	$63,000,000	0
Non-Federal	0	15,000,000	0
Recreational navigation			
Federal	0	200,000	0
Non-Federal Public	$220,000	1,200,000	$1,800,000

Summary of annual maintenance costs

Feature	1966-1980	1981-2000	2001-2020
Commercial navigation:			
Federal	$350,000	$650,000	$800,000
Recreation navigation:			
Non-Federal	0	20,000	20,000

SACRAMENTO BASIN SUBREGION

TABLE SB-1

Existing and Projected Commercial Navigation Features and Terminal Facilities

	1965	1980	2000	2020
Navigation features:				
Channel:				
Depth, feet	6	6	6-12	6-12
Width, feet	150	150	200	200
Length, miles				
Sacramento	85	85	85	85
Feather River	0	0	19	19
Turning basins:				
Depth, feet	0	0	12	12
Area, acres	0	0	9	9
Terminal facilities:				
Berths, number	5	5	10	10
Cargo-handling area, acres	2	2	42	42

SACRAMENTO BASIN SUBREGION

TABLE SB-2

Recreation Navigation Needs, 1965-2020

	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	0.9	0.9	1.0	1.0
Subregion population, thousands	1,089	1,534	2,742	4,977
Number of berths needed	1,000	1,500	2,750	4,900
Trailered boats				
Number of trailered boats using navigable waters	790	1,300	2,300	4,000
Number of peak-day launchings	250	450	750	1,200
Launching facilities needed 1/	10	15	24	38

1/ Launching lanes 12 feet wide or hoists with launching capacity of 40 boats per peak day.

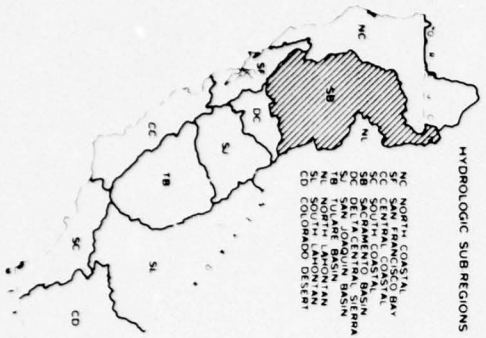
SACRAMENTO BASIN SUBREGION

TABLE SB-3

Summary of Plan to Meet Needs for Recreational Navigation

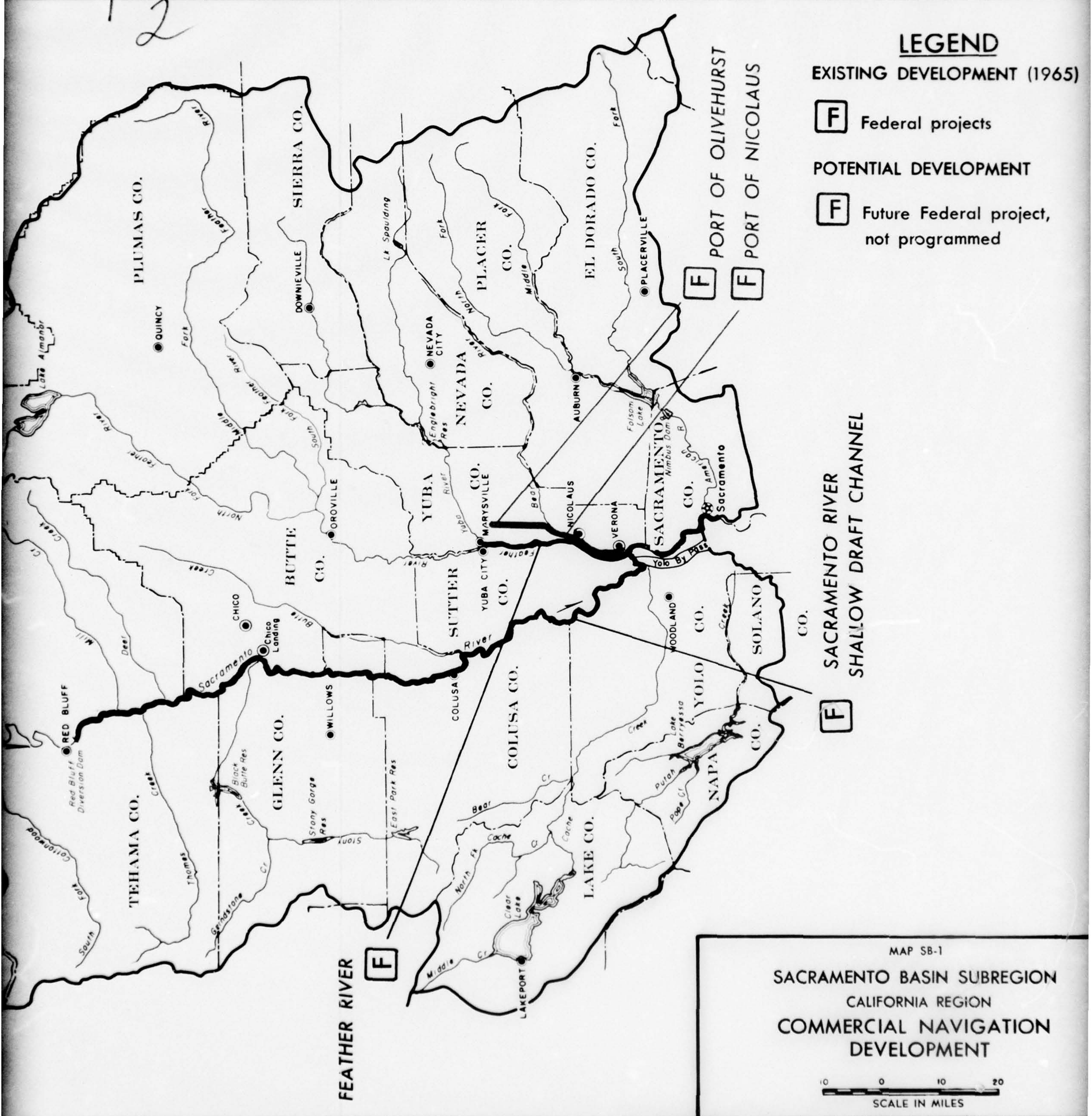
Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	1,000	500	1,500	1,250	2,750	2,150	4,900
Needs met:							
Within facilities existing in 1965	1,000	0	1,000	0	1,000	0	1,000
Within facilities definitely programmed in 1965	0	0	0	0	0	0	0
Within projected facilities not programmed in 1965	0	200	200	1,000	1,200	1,800	3,000
Incremental additions		200		1,000		1,800	
TOTAL	1,000		1,200		2,200		4,000
Residual un-met needs	0		300		550		900
Launching lanes							
Needs	10	5	15	9	24	14	38
Needs met:							
By lanes existing in 1965	41	0	41	-5 1/	36	-5 1/	31
By projected lanes	0	4	4	0	4	0	4
Incremental additions		4		5		5	
TOTAL	41		45		40		35
Residual un-met needs	0		0		0		3
Transient moorings 2/							

1/ Through obsolescence of lanes existing in 1965.
2/ Not applicable in this subregion.

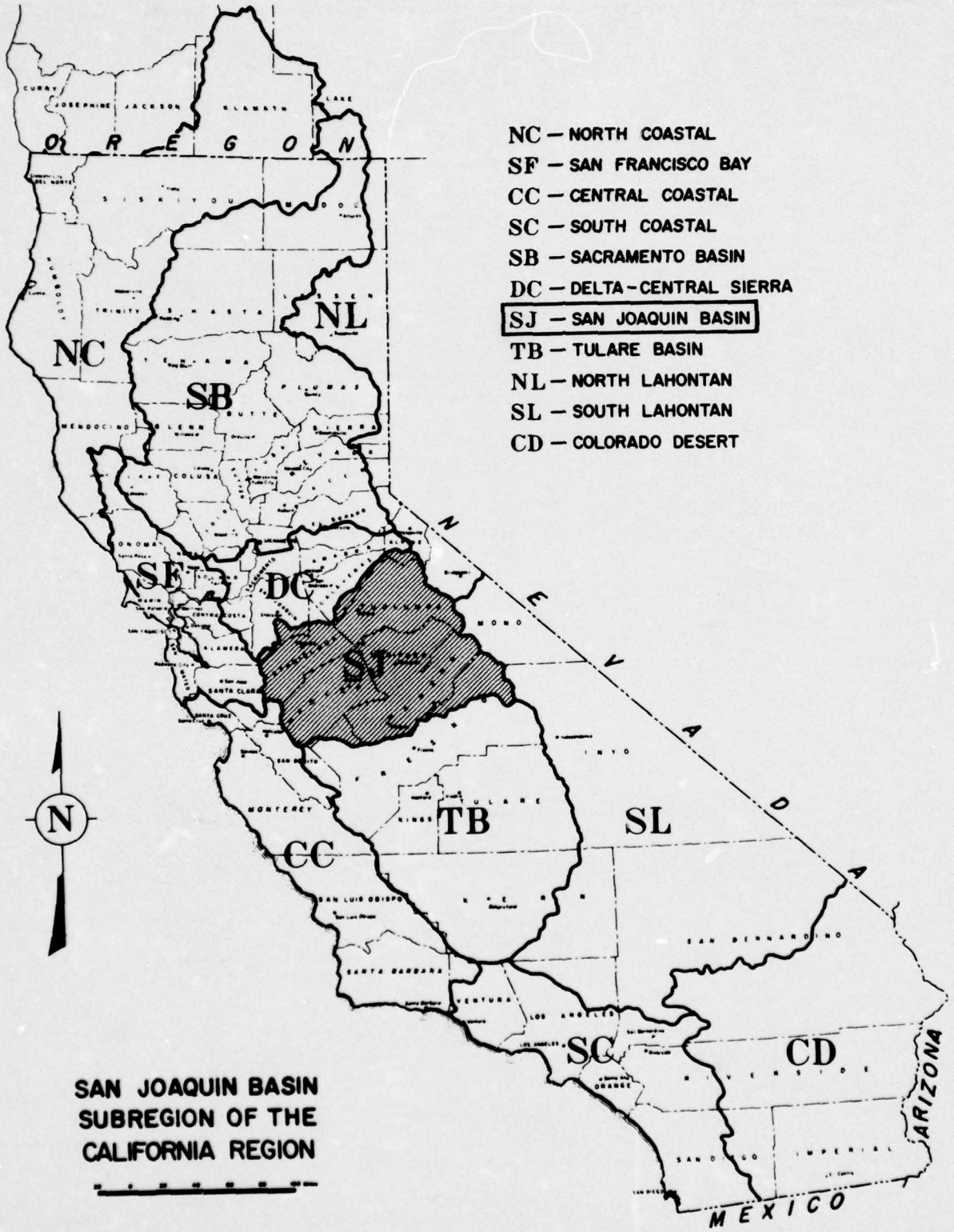


OREGON
CALIFORNIA

Quarts Cr
Thomas
Cottonwood Res
Drews Res
LAKEVIEW
Dog Lake
Goose Lake
N Fk
ALTURAS
South Fork
River
SISKIYOU CO.
MODOC CO.
LASSEN CO.
Mud Cr
MT SHASTA
River
Sacramento R
McCloud Cr
Pit River
Hat Cr
Squaw Pit
Clear Cr
Shasta Lake
Keswick Res
Whiskeytown Res
REDDING
SHASTA CO.
N
Middle Fork Cottonwood Cr
Battle Cr
Digger Cr
S Fk
South Fork Cottonwood Cr
Red Bluff Diversion Dam
RED BLUFF
Mill Creek
Lake Almanor
Deer
River
TEHAMA CO.
PLUMAS CO.


LEGEND
EXISTING DEVELOPMENT (1965)
F Federal projects
POTENTIAL DEVELOPMENT
F Future Federal project, not programmed
F PORT OF OLIVEHURST
F PORT OF NICOLAUS
F SACRAMENTO RIVER SHALLOW DRAFT CHANNEL
F FEATHER RIVER
PLUMAS CO.
SIERRA CO.
PLACER CO.
EL DORADO CO.
NEVADA CO.
YUBA CO.
BUTTE CO.
SUTTER CO.
SACRAMENTO CO.
TEHAMA CO.
GLENN CO.
COLUSA CO.
YOLO CO.
SOLANO CO.
LAKE CO.
NAPA CO.
QUINCY
DOWNIEVILLE
NEVADA CITY
AUBURN
PLACERVILLE
OROVILLE
MARYSVILLE
YUBA CITY
NICOLAUS
VERONA
Sacramento
CHICO
Chico Landing
RED BLUFF
Red Bluff Diversion Dam
WILLOWS
COLUSA
WOODLAND
LAKEPORT
Folsom Lake
Nimbus Dam
Yolo By Pass
Lake Berryessa
Clear Lake
Black Butte Res
Stony Gorge Res
East Park Res
Englebright Res
Lk Spaulding
Lake Almanor
Sacramento
River
MAP SB-1
SACRAMENTO BASIN SUBREGION
CALIFORNIA REGION
COMMERCIAL NAVIGATION DEVELOPMENT
10 0 10 20
SCALE IN MILES

SAN JOAQUIN SUBREGION



SAN JOAQUIN BASIN
SUBREGION OF THE
CALIFORNIA REGION

SAN JOAQUIN BASIN SUBREGION

General

The San Joaquin Basin subregion is situated in central California and extends, generally, from the city of Stockton on the north to Fresno on the south. It is bounded by the Sierra Nevada Range on the east, the Coast Range on the west, and the Delta-Central Sierra subregion on the north. The subregion is described in detail in Appendix II. The only portion of the subregion of importance to channel navigation is the San Joaquin River downstream of the Merced River and the lower reach of the Tuolumne River. (See Map SJ-1)

Irrigated agriculture in the Central Valley is the dominant economic activity in the subregion, with crops ranging from oranges and cotton in the southern basin, vineyards in the central basin, and truck farms in the north. The major industrial activity centers around food processing and packing. Mining and lumber are important in the Sierra Nevada area.

Existing Development

COMMERCIAL NAVIGATION

The San Joaquin River Shallow-Draft Project was authorized by the River and Harbor Act of 1876 and modified by Acts of 1881, 1884, 1888, 1892, 1894, 1896, 1910, and 1912. Acts prior to 1910 included provisions, (1) for cutting off sharp bends and making cutoffs in the San Joaquin River below Stockton, and (2) for snagging and removing obstructions and constructing wing dams in the San Joaquin River from the Stockton Channel upstream to Hills Ferry at the mouth of the Merced River, without adopting any specific dimensions. The River and Harbor Act of 1910 provided for a 9-foot channel up to Stockton.

Controlling depth upstream from Stockton to Hills Ferry is presently about 3 feet. Low flows in the San Joaquin River in nonflood periods, and relatively steep slopes, make modern shallow-draft commercial navigation in the subregion infeasible. No additional water releases from upstream reservoirs solely to meet navigation requirements appear warranted. There is presently no commercial traffic on streams in the subregion.

RECREATIONAL NAVIGATION

Approximately 66 miles of waterway in the subregion is suitable for recreational navigation, including the San Joaquin River downstream of the Merced River (62 miles) and the lower Tuolumne River (4 miles).

Summer releases to the Merced River and the Stanislaus River, except in years of heavy snowmelt runoff, are so low as to make these streams unsuitable for recreational navigation.

No detailed studies of recreational use or boating use have been made for this subregion. Most boating activity in the subregion originates in the Delta-Central Sierra subregion immediately to the north. There are no known boating facilities on navigable streams in the subregion, as indicated by the data in Table SJ-5.

The San Joaquin River carries large floodflows in the winter and spring flood periods, and boating is hazardous at such times. Marina developments along the river would be subject to potential damage, as in the Sacramento Basin subregion. It is estimated that in 1965 approximately 70 percent of boating use on navigable waterways in the subregion was derived from launched boats; however, this percentage is expected to drop to approximately 50 percent in the future, as indicated by the data in Table SJ-1.

Future Needs

COMMERCIAL NAVIGATION

Estimates of future needs for commercial navigation were assessed in terms of projected waterborne commerce tonnages. A reconnaissance evaluation in 1964 of potential traffic on a shallow-draft waterway from Stockton upstream to the mouth of the Merced River indicated that approximately 2,000,000 tons of commerce originated in or was destined for the service area and that in the order of 40 percent of the gross tonnage, or approximately 760,000 tons annually, might move via an improved channel. Principal commodities would be sugar beets, grains, rice, petroleum products, and steel.

The 1964 reconnaissance study indicated that, because of low flows and steep slopes in the San Joaquin River from Stockton upstream to Hills Ferry, canalization by a series of locks and dams would be required to provide adequate depths of commercial navigation. However, the study indicated that benefits would be substantially less than costs, and canalization would not be economically feasible. Private engineers have proposed comprehensive multiple-purpose plans in the San Joaquin Valley, including large-scale navigation development of the San Joaquin River, but it appears doubtful that the navigation component of these plans would be economically justified in the foreseeable future. Although there is no significant need for improvements for commercial navigation in the subregion at present, further consideration should be given to providing such facilities if the economy of the subregion changes radically in the future.

RECREATIONAL NAVIGATION

Future needs for recreational navigation were assessed in terms of launching facilities and berthing facilities, and are summarized in Table SJ-1. The San Joaquin River and the lower Tuolumne River are presently navigable by some recreational craft during moderate flow periods. Boat ownership in the subregion has increased rapidly in recent years, as indicated by the following data, tabulated by counties in the recreation-use area.

County	Number of boats per thousand population		
	December 1960	December 1965	December 1967
Merced	11.7	18.1	22.8
Stanislaus	23.1	32.5	40.5
Market area average	17.4	25.3	31.6
State-wide average	14.3	18.3	21.5

These data indicate that boat ownership in the subregion is higher than the state-wide average. However, the large number of lakes and reservoirs in the subregion makes boating in navigable channels a secondary recreational choice, accounting for the small number of such boats per thousand population shown in Table SJ-1.

Projections of future needs for berthing spaces and launching ramps and deficiencies are shown in Table SJ-2. These data indicate there will be a growing deficiency in berthing spaces, but that launching facilities will be approximately adequate in the subregion. Estimates of 1965 use and projections of future boat days and recreation days, reflecting average party size, are as follows:

Year	Boat days	Recreation days
1965	9,000	36,000
1980	12,000	48,000
2000	18,000	72,000
2020	30,000	120,000

Means To Satisfy Future Needs

RECREATIONAL NAVIGATION

Preliminary evaluations indicate that because of the small demand channel improvements for recreational boating would not be economically feasible. The number of recreational facilities needed to satisfy the estimated future boating use is shown in Table SJ-1. The number of boat-launching facilities needed was based on Corps of Engineers standards. Facilities for berthed boats and dry storage are expected to be supplied by private development, as in the adjoining Delta-Central Sierra subregion. It is expected that boat-launching ramps required will be provided by State and local agencies and by private developments. Data in Table SJ-2 indicate facilities will lag behind need, as can be expected with private development.

Implementation

Data in the preceeding paragraphs indicate that channel improvement for commercial and recreational navigation in the San Joaquin Basin subregion will not be feasible, and no plan of improvement has been developed. Berthing and launching facilities are projected to be supplied by private investment, and it is estimated that the cost of these facilities would be about $1,000 per berth and about $10,000 per 2-lane launching ramp. Estimated private total first costs of facilities are projected to be as follows:

	1965-1980	1981-2000	2001-2020
Recreational navigation			
Private	$20,000	$205,000	$305,000

The private costs of maintenance of these facilities were not estimated.

SAN JOAQUIN BASIN SUBREGION

TABLE SJ-1

Recreational Navigation Needs, 1965-2020

	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	0.3	0.6	0.6	0.5
Subregion population, thousands	385	487	853	1,626
Number of berths needed	100	290	500	800
Trailered boats				
Number of trailered boats using navigable waters	180	290	500	900
Number of peak-day launchings	45	80	135	250
Launching facilities needed 1/	2	3	5	8

1/ Launching lanes 12 feet wide or hoists with launching capacity of 40 boats per peak day.

SAN JOAQUIN BASIN SUBRECION

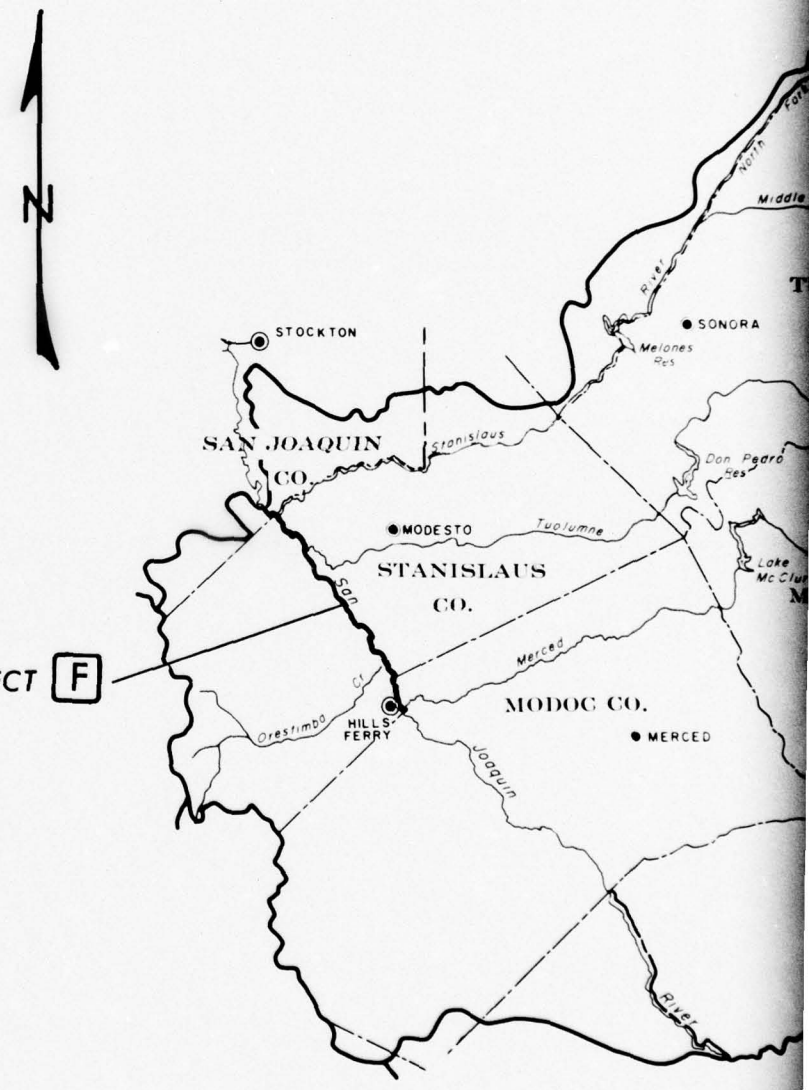
TABLE SJ-2

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	100	190	290	210	500	300	800
Needs met:							
Within facilities existing in 1965	0	0	0	0	0	0	0
Within facilities definitely programmed in 1965	0	0	0	0	0	0	0
Within projected facilities not programmed in 1965	0	0	0	200	200	300	500
Incremental additions		0		200		300	
TOTAL	0		0		200		500
Residual un-met needs	100		290		300		300
Launching lanes							
Needs	2	1	3	2	5	3	8
Needs met:							
By lanes existing in 1965	0	0	0	0	0	0	0
By projected lanes	0	4	4	1	5	1	6
Incremental additions		4		1		1	
TOTAL	0		4		5		6
Residual un-met needs	2		0		0		2
Transient moorings 1/							

1/ Not applicable in this subregion.

SAN JOAQUIN RIVER SHALLOW-DRAFT PROJECT [F]



1
2

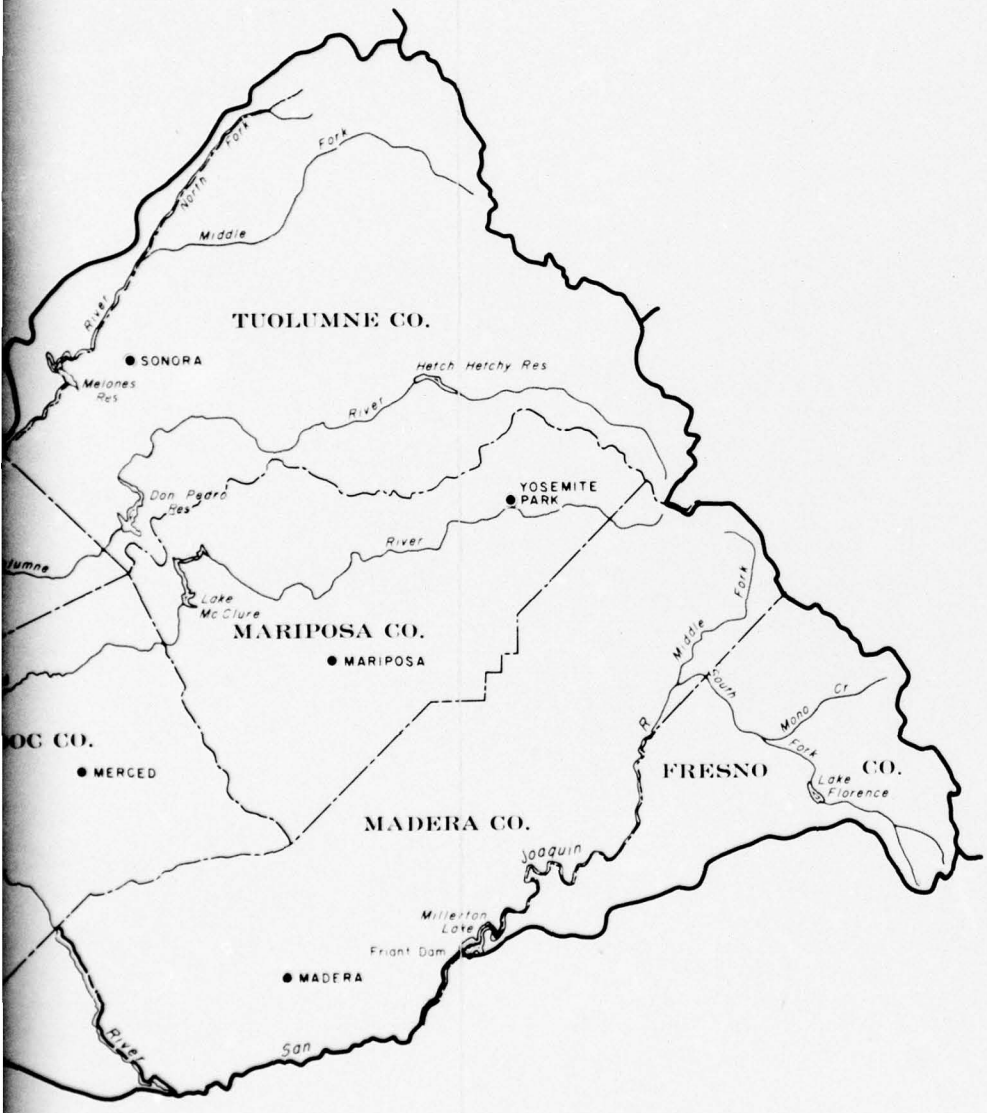
LEGEND

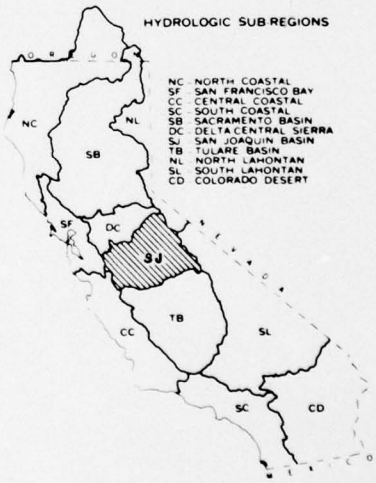
EXISTING DEVELOPMENT (1965)

[F] Federal projects

POTENTIAL DEVELOPMENT

None





MAP SJ-1

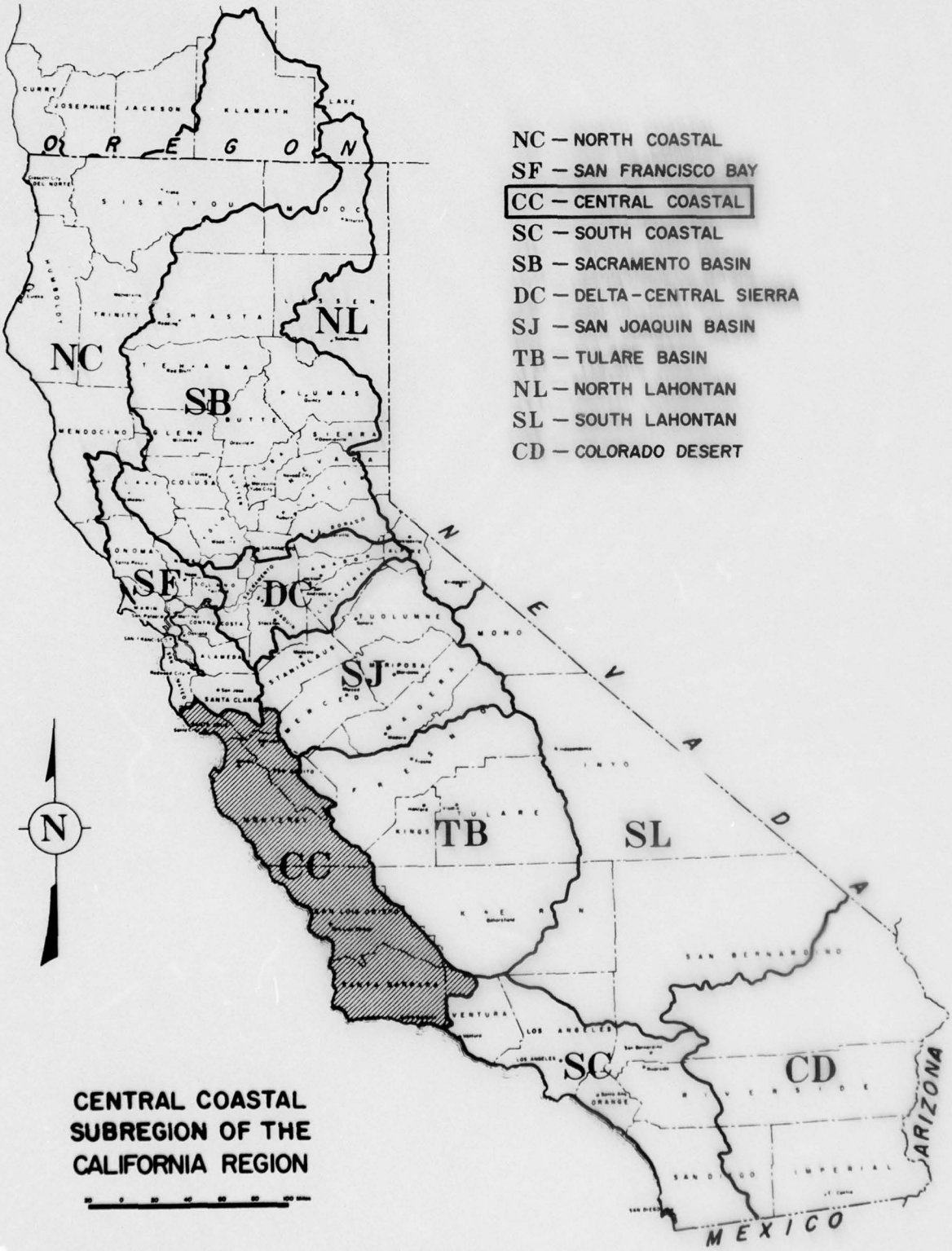
SAN JOAQUIN BASIN SUBREGION
CALIFORNIA REGION

COMMERCIAL NAVIGATION DEVELOPMENT

10 0 10 20

SCALE IN MILES

CENTRAL COASTAL SUBREGION



CENTRAL COASTAL SUBREGION OF THE CALIFORNIA REGION

CENTRAL COASTAL SUBREGION

General

The Central Coastal subregion extends along the Pacific Ocean from Point Ano Nuevo, in San Mateo County, south to near the Santa Barbara-Ventura County line and from the ocean inland to the crest of the coast ranges. The subregion is described in detail in Appendix II.

The Central Coastal subregion had less than 4 percent of the Region's population in 1965. Its economy was supported primarily by agriculture and related industry. In addition, manufacturing, petroleum, mineral production and the recreation industry are contributors to the basic economy.

The Central Coastal subregion has one natural, landlocked bay - Morro Bay. There are no navigable rivers or inland waterways. Existing navigation facilities consist of six shallow-draft harbors, accommodating light-draft commercial-fishing vessels and recreational small craft; and six privately-constructed deep-draft terminal facilities, consisting of pipelines or piers. These navigation facilities are shown on Map CC-1.

The large ports of the California region have developed at San Francisco Bay and at Los Angeles-Long Beach harbors. Overland trade routes through the generally mountainous and sparsely-settled Central Coastal subregion connect with the large population centers to the north and south. The 1965 waterborne commerce of the Central Coastal subregion amounted to about 7,423,000 tons, which was less than 6 percent of the waterborne commerce of the California region.

Waterborne commerce in the subregion has consisted almost entirely of shipments of locally-produced petroleum and petroleum products. Fish and shellfish, amounting to about 19,000 tons in 1965, represented less than 1 percent of the subregion's total commercial tonnage. Waterborne commerce is summarized in Table CC-1. The tributary area for commercial navigation is limited to the subregion.

In 1965, an estimated 11,000 small craft, about 3 or 4 percent of California's total fleet, were registered in the Central Coastal subregion. About 1,700 small craft, both recreational and commercial, were permanently berthed or moored in the harbors in 1965. About 200 of these vessels occupied unsafe or substandard moorings. With few exceptions, small craft permanently berthed or moored in the subregion are owned by residents of the subregion. Trailered boats using the ocean in the subregion, and the protected waters of Morro Bay, are drawn

from other subregions, particularly, the San Joaquin, Tulare Basin, and San Francisco Bay subregions, as well as from the Central Coastal subregion. The existing small-craft berthing facilities are included in Table CC-4.

It is estimated that 1,000 intracoastal passages, northbound or southbound, were made by pleasure boats in 1965. The population centers in Southern California and the San Francisco Bay area produce the preponderance of the recreational small craft using the ocean; the major intracoastal small-craft traffic is between these two boating centers. Morro Bay is the only harbor of refuge between Santa Barbara and Monterey - a distance of over 200 nautical miles. The 110 nautical miles between Morro Bay and Santa Barbara are far in excess of the 35-mile distance between harbors of refuge considered desirable for safe operation of small craft cruising the coast. The Channel Islands are the destination for many pleasure craft and fishing vessels in both the South Coastal and Central Coastal subregions. There are no harbors of refuge on the islands.

Existing Development

GENERAL

The harbors of the subregion are all shallow-draft; deep-draft facilities consist of offshore-petroleum terminals, either pipelines or piers. In 1965, there were six offshore-petroleum terminals, located at Carpenteria, Ellwood, Gaviota, Capitan, San Luis Obispo, and Estero Bay. The facilities were constructed and are maintained by private oil companies. All except San Luis Obispo consist of moorings in from 32- to 60-foot depths of water with submarine pipeline connections to shore. (See Table CC-2) San Luis Obispo terminal is a pier with depths alongside of about 32 feet. The subregion's six shallow-draft harbors serve both recreation and commercial vessels. The most southerly existing harbor in the subregion is Santa Barbara Harbor, located about 23 nautical miles upcoast from Ventura Marina, in the South Coastal subregion. It is 89 nautical miles from Santa Barbara Harbor to the next harbor north, Port San Luis, which is not an all-weather harbor. Morro Bay Harbor is located 21 nautical miles north of Port San Luis; and Monterey Harbor, 102 nautical miles north of Morro Bay Harbor. Moss Landing Harbor, 13 nautical miles upcoast from Monterey Harbor, and Santa Cruz Harbor, 27 nautical miles upcoast from Monterey Harbor, complete the subregion's existing shallow-draft facilities. These harbors are briefly described in the following paragraphs.

SANTA BARBARA HARBOR

Santa Barbara Harbor, completed by local interests in 1930, is formed by a breakwater about 2,800 feet long. From its inception, the harbor was subject to extensive shoaling. A large sandspit developed at the downcoast end of the breakwater, and downcoast beaches were deprived of littoral material intercepted at the harbor, causing serious beach erosion problems. A Federal maintenance project for Santa Barbara Harbor was authorized by the 1935 and 1945 River and Harbor Acts. The 1935 authorization provided for maintenance by dredging to the depths existing in 1934; the 1945 authorization permitted maintenance of the harbor by means of a fixed sand-intercepting plant. The plant was to be provided and operated by local interests who would be reimbursed by the Federal Government a maximum of $30,000 annually towards operating costs. Because of extensive shoaling in the harbor, maintenance dredging is continually required. Most of the dredged material has been deposited on the downcoast beaches to compensate for the continuous erosion that threatens valuable shoreline property.

The existing entrance channel is about 15 feet deep, 300 to 400 feet wide, and 1,500 feet long. Commercial terminal facilities in the harbor consist of a wharf 2,200 feet long and a pier 335 feet long. The wharf is used for general cargo and for servicing fishing and oil exploration boats; the pier services light commercial boats. Waterborne commerce in 1965 consisted of about 1,500 tons of fish and fish products. In 1965, there were 565 permanently berthed or moored boats in the harbor, consisting of fishing boats, commercial work boats, and recreational boats. The harbor berthed or moored 750 boats in 1968; all slips were occupied and the mooring area was seriously overcrowded.

The Federal maintenance project was modified by the 1962 River and Harbor Act, which authorized construction of small-craft harbor improvements that would enable the harbor to accommodate 2,700 small craft and serve as a harbor of refuge. These improvements have not been constructed, pending the development of a plan by local interests to fund their share of the Federal project.

PORT SAN LUIS

Port San Luis, formerly San Luis Obispo Harbor, was improved as a Federal navigation project by the Corps of Engineers. The project, completed in 1913, consists of a breakwater extending about 2,400 feet southward from Point San Luis. The Federal first costs of the project were about $568,400. Federal maintenance costs to 1 July 1965 were about $60,000. Three wharfs are located within the sheltered area - a private wharf used by commercial and sport fishermen, a private wharf servicing deep-draft petroleum vessels, and a public wharf used by fishing and pleasure craft. The harbor is open to storms approaching from the south and southwest and is not an all-weather harbor.

In 1965, waterborne commerce consisted of over 864,000 tons of petroleum and petroleum products, and about 300 tons of fish and shellfish. The harbor is used by about 30 commercial fishing boats and 20 recreational small craft. All of these boats are moored; there are no berthing facilities. Fuel and water are available, and small boats can be landed on the beach. There is a launching hoist for trailered boats on the public wharf and on the private fishing-wharf.

The River and Harbor Act of 1965 authorized modification of the existing project to provide construction of improvements for both deep and shallow-draft navigation. Since that date, the project plan has been further modified to defer the deep-draft improvements, pending future needs. Studies presently underway indicate a need for improvement of the harbor, for small craft only, by constructing about 5,600 feet of additional breakwater. Local interests plan to construct berthing facilities for about 1,500 small craft within the protected area.

MORRO BAY HARBOR

Construction of harbor improvements at Morro Bay, the only natural bay in the subregion, was commenced in 1942 by the Corps of Engineers, with U.S. Navy funds. The existing Federal project, authorized by the 1945 River and Harbor Act, was completed in 1946. The authorized improvement consists of about 3,700 feet of breakwaters; a dike 1,600 feet long between Morro Rock and the mainland; about 7,000 feet of revetted levee; an entrance channel 16 feet deep, 350 feet wide and 2,500 feet long; the Navy channel, 16 feet deep, 350 to 800 feet wide and 4,500 feet long; and the Morro channel, 12 feet deep, 150 feet wide, and 5,300 feet long. The Federal first cost for the part of the project authorized for construction by the Corps of Engineers was about $2,612,000. Federal maintenance costs have amounted to about $2 million. In addition, rehabilitation of deteriorated structures and channels was completed in 1964 at a Federal first cost of $2,128,000. An additional $2 million has been spent by local and private interests. The harbor provides berthing facilities for both commercial-fishing vessels and pleasure craft. Waterborne commerce, consisting mostly of fish and fish products, and some construction and mining machinery and parts, amounts to about 7,000 tons a year. During moderate seas, some of the smaller boats at Morro Bay have difficulty maneuvering in the entrance channel; in heavy seas, the entrance channel becomes extremely dangerous for all vessels entering or leaving the harbor. Because of the conditions in the entrance channel, the harbor is effectively closed to traffic for 20 to 30 days each year. A study to determine the advisability of modifying the existing project, chiefly to provide facilities for additional small craft, is being conducted by the Corps of Engineers.

MONTEREY HARBOR

The improvement of Monterey Harbor was initiated under the authority of the 1930 River and Harbor Act, which authorized construction of a breakwater 1,300 feet long. In 1934, a 400-foot extension to the breakwater was constructed under the Public Works Program and authorized, after-the-fact, by the 1935 River and Harbor Act. The 1945 River and Harbor Act authorized dredging of the area adjacent to Municipal Wharf No. 1 to a depth of 8 feet; this work was completed in 1947. The 1960 River and Harbor Act authorized a 1,700-foot-extension of the existing breakwater and an L-shaped companion breakwater on the basis of model tests now completed. A detached offshore north breakwater about 3,300 feet in length and a companion west breakwater about 1,100 feet long are now proposed. The modified plan would add about 600 feet of breakwater to the project document plan. Federal funds expended for construction and maintenance work performed by the Corps of Engineers amount to about $1,100,000, of which about $80,000 is for maintenance. The harbor provides berthing facilities for about 350 recreational small craft and mooring facilities for about 30 commercial fishing boats. The present breakwater does not provide sufficient protected anchorage for all fishing craft based at the harbor. During fish runs, more than 100 commercial-fishing boats operate from the harbor. When storms or heavy surge occurs, vessels break from their moorings and collide with other vessels, or wharves, or are driven onto the beach. The modified project plan will provide protected berths for about 1,300 small craft by the year 1990. Moorings for commercial-fishing boats would be increased to about 300. No deep-draft commercial facilities are planned for Monterey Harbor at this time.

MOSS LANDING HARBOR

The 1945 River and Harbor Act authorized construction of jetties; an entrance channel 200 feet wide and 15 feet deep; and an interior channel 100 feet wide, 3,200 feet long, and 15 feet deep, including a turning basin 200 feet wide, 400 feet long, and 15 feet deep. Work was completed by the Corps of Engineers in 1947 as authorized. A review study was authorized in 1947. This study will investigate the feasibility of modifying the existing Moss Landing Harbor project to include deep-draft commercial-shipping facilities. Present facilities serve a commercial-fishing fleet of approximately 200 vessels, which are berthed in the South Harbor in the east shore marina. Approximately 50 recreation craft are also berthed in the marina. On the west shore, unloading facilities and a fish cannery serve the fishing fleet. Fish buyers, representing canneries in other areas, purchase fish for shipment to their canneries. Additional berths to accommodate 50 additional craft are now under construction. No berths are available in Elkhorn Slough, which is a continuation of the entrance channel, due primarily to the low clearance under the highway bridge - about 6 feet at average tide. The North Harbor provides berths for 65 yachts in a private facility whose lease with the local harbor district expires in 1981.

SANTA CRUZ HARBOR

Santa Cruz Harbor was constructed under the authority of the 1958 River and Harbor Act, which provided for a small-craft harbor in Woods Lagoon, near the city of Santa Cruz. The harbor, which was completed in 1963, has an entrance channel 100 feet wide and 15 to 20 feet deep, protected by two jetties, one 850 feet long and the other 1,125 feet long. Other elements of the Federal project are a channel 150 feet wide and 10 to 15 feet deep and a turning basin 10 feet deep with an area of about 1.7 acres. Total Federal cost as of 1 July 1965 was about $1,515,000 for new work and $158,000 for maintenance. Local interests' share of the cost of the navigation features was $1,062,000. The authorized project also provides for construction of a sand-bypassing plant, for which planning is now in progress. The sand-bypassing plant will cost an additional $300,000 or more. The Federal Government will maintain the jetties at an estimated cost of $15,000. Upon completion of the sand-bypassing plant, local interests will assume maintenance of the channels and the turning basin and will operate and maintain the plant, for which they will be reimbursed by the Federal Government a maximum of $35,000 annually. The harbor handled only 213 tons of waterborne commerce - all fish - in 1965 and berthed about 360 recreational boats and six fishing boats. Local interests plan to double the capacity of the harbor by 1972; however, further excavation of the lagoon, which is a valuable wildlife habitat, will probably be opposed by conservation interests.

Future Needs

COMMERCIAL NAVIGATION

Future needs for commercial navigation were assessed in terms of projected waterborne commerce tonnages. These projections indicate that waterborne commerce will comprise petroleum and petroleum products, moving through deep-draft offshore terminals, and minor quantities of fresh fish. The general needs of the tributary area can be met, as they are at present, by the ports of the South Coastal and San Francisco Bay subregions. Present commerce in petroleum and petroleum products consists in part, of domestic petroleum products to serve the needs of fossil-fuel power generating plants. It has been assumed that a part of the future power requirements of the Central Coastal subregion will be met by fossil-fuel plants. Tankers with greater drafts may join the coastwise fleet, requiring extension of some existing submarine pipelines into deeper water.

The projected population growth in the Salinas Valley directed attention to the alternative of providing a secondary local port at Moss Landing to serve this area. Moss Landing Harbor is at the head of a pronounced submarine canyon, and has exceptionally suitable entrance

conditions for a commercial harbor; however, the existing harbor configuration and other physical constraints would limit expansion for commercial navigation. Within existing limits, it is estimated that a facility could be developed to handle about 2,000,000 tons of waterborne commerce annually. However, by widening, deepening and realigning harbor waterways to accommodate vessels with drafts of 45 feet, the potential capacity of the harbor could approximate 5,000,000 tons of waterborne commerce annually. Waterborne commerce projected for Moss Landing Harbor is part of that included in the projections for the San Francisco Bay subregion; if the Moss Landing alternative was determined to be feasible, waterborne commerce projections for the San Francisco Bay subregion would be reduced by an equivalent amount. There is insufficient data upon which to base a decision at this time, however further study of this alternative appears warranted. The estimated cost of developing commercial navigation features at Moss Landing is estimated at $10 million, of which about $1 million would be Federal costs.

The commercial small-craft fleet is largely comprised of fishing boats, including party boats. Party boats are those that carry passengers for the purpose of sport fishing. All commercial-fishing boats, including party boats, are presently decreasing in number. The decrease in the size of the commercial-fishing fleet may be attributed in part to the loss of the California sardine, an important forage fish, and in part to other factors, which include more efficient equipment and techniques, larger vessels, and fewer part-time fishermen. Whatever the reason, the trend in commercial-fishing boats has been downward. No major increase is likely in the number of vessels involved, although their average length may increase. The commercial and party-boat fishing fleet can be accommodated in the harbors required to meet the recreational small-craft needs of the subregion; however, a need for additional terminal facilities for the receipt of fresh fish is indicated. Additional terminal facilities would enable the fishing fleet to more efficiently harvest the ocean resources of the subregion.

RECREATIONAL NAVIGATION

General

Projections of future recreational-boat ownership was based on the methodology used in the "California Small-Craft Harbors and Facilities Plan, Comprehensive Report", dated March 1964, prepared for the State of California. The future needs for recreational navigation were assessed in terms of permanent berthing facilities, launching facilities, and transient and destination facilities. These needs are discussed in the following paragraphs and are summarized on Table CC-3.

Berthing Facilities

Present and projected needs for berthing facilities were based upon evaluation of the positive effects of increased disposable income on berthable-boat ownership and the negative effects of congestion. Congestion would not have a measurable effect upon the Central Coastal subregion. The theoretical ratio of berthable boats to population was estimated at 2.5 berthable boats per thousand population in 1965, 3.8 in 1980, 5.0 in 2000, and 5.5 in 2020. Applying the computed ratios to population projections for the subregion resulted in a theoretical demand for berths for about 22,000 boats by the year 2020. The subregion's existing shallow-draft harbors will require enlargement and additional new harbors would be required to accommodate the projected berthing needs. (See Table CC-4.)

Trailered-boat Facilities

The present and projected needs for trailered-boat facilities were based upon the estimated use of ocean waters by trailered-boats as presented in the "Comprehensive Report" previously cited. Trailered-boat facilities in the Central Coastal subregion serve several adjacent subregions. Future needs include additional coastal launching sites to provide access to presently inaccessible reaches of the coast and to serve dispersed population centers. All of the required launching ramps would not, initially, be utilized to full peak-day capacity; however, as the trailered-boat population increases, launching ramp use would approach maximum peak-day capacity. Estimated launching facilities required are given in Table CC-3.

Transient and Destination Facilities

The 110 nautical miles between Santa Barbara Harbor and Morro Bay, and the 102 nautical miles from Morro Bay to Monterey Harbor are dangerously long reaches of shoreline for small vessels during periods of adverse weather. A long-accepted criteria has been that all-weather harbors of refuge should be spaced about 35 nautical miles apart. This distance is based on considerations of how far a small vessel can travel after receipt of weather warnings, and under worsening weather conditions, to reach refuge.

Intracoastal cruising by recreational vessels, at the present time, is severely constrained by the lack of a chain of harbors of refuge in the subregion. Additional harbors of refuge would be required to provide increased safety for ocean boaters by minimizing the risk to life and property from sea and weather hazards and from accidents. These harbors would also enhance recreational opportunities by providing new boating destinations, thus encouraging cruising, opening presently under-exploited fishing-grounds to recreational fishing, and making additional ocean reaches and coastal segments available to boaters with safety.

Each all-weather harbor of refuge would require the following facilities: (1) an entrance that can be navigated at all but the most extreme periods of the worst storms; (2) appropriate navigation aids; (3) a public landing; (4) a protected anchorage area for transient vessels; (5) land access; (6) communications facilities; (7) fuel for transient boats; (8) a potable water supply and (9) sanitary facilities. The estimated peak-period overnight transient use is summarized in Table CC-3.

Means to Satisfy Future Needs

The means to satisfy future needs for commercial navigation in the Central Coastal subregion would consist of extension of offshore-petroleum facilities by private interests, if required, and provision of mooring and terminal facilities for light-draft commercial vessels in existing and future shallow-draft recreational harbors. The means to satisfy future needs are defined in terms of required berths and terminal facilities. (See Table CC-2.) The future needs for light-draft recreational and commercial navigation could be met through providing a chain of harbors, spaced generally 35 nautical miles apart, and providing protected water area sufficient to berth the recreational and commercial small craft generated by the subregion. These harbors would also provide destinations for cruising recreational boats and launching facilities for trailered boats desiring to use the coastal waters of the subregion. (See Table CC-5.)

Natural sites that could be improved to provide harbors of refuge at reasonable cost are very few along the Central coast. The most suitable sites in the reach from Santa Barbara to Morro Bay are Cojo Anchorage, near Point Conception, and Point Sal. The most suitable sites in the reach from Morro Bay to the north boundary of the subregion are San Simeon Bay and the mouth of Big Sur River, near Point Sur. With the existing harbors, these additional harbors would provide, generally, a 35-mile spacing, although the distance between San Simeon and Big Sur is about 51 nautical miles. Unfortunately, there is no reasonable site in this reach; development of an additional harbor could be accomplished, but at a very high cost. The Channel Islands do not have any harbors or all-weather natural protection. The islands afford a very desirable destination for recreational boats and are also an important fishing area. A minimum of one harbor of refuge on each island -- Santa Cruz, Santa Rosa and San Miguel -- would be required. Future public acquisition of Santa Cruz and Santa Rosa Island would be highly desirable and would help to relieve considerable pressure on overcrowded destinations in the South Coastal subregion.

The required additional berthing capacity could be provided by expanding the subregion's six existing shallow-draft harbors; by developing two new multiple-purpose harbors -- one in the vicinity of Sand Point and one in the vicinity of Santa Cruz Point; and by providing for future development of Cojo and San Simeon harbors of refuge into multiple-purpose harbors. Trailered-boat facilities adequate to meet future needs could be constructed within existing and future harbors, within Morro Bay, along the mainland shoreline at protected locations south of Point Conception, and within Monterey Bay.

Estimated future needs for launching and berthing facilities, and deficiencies are shown in Table CC-5.

At present, terminal facilities for fresh fish and minor quantities of general cargo are located at Santa Barbara Harbor, Port San Luis, Morro Bay Harbor, Monterey Harbor, and Moss Landing. It is recommended that additional terminal facilities should be provided at two of the additional harbors of refuge that would be required. Most likely sites for these facilities are Point Sal and San Simeon Bay.

Implementation

Construction of navigation facilities in the Central Coastal subregion would require dredging or filling of about 27 million cubic yards of material between the years 1966 and 2020, and construction of about 8.8 miles of protective breakwaters and jetties. This work would all be in connection with shallow-draft facilities for small craft, primarily recreational boats. If a secondary commercial port at Moss Landing were to be developed, dredging of an additional 1,200,000 cubic yards would be required. Estimated construction quantities for recreational navigation features, are as follows:

Item	Unit	1966-1980	1981-2000	2001-2020
Dredging navigation features	Cu. yds.	3,600,000	1,600,000	4,000,000
Other dredging or borrow	Cu. yds.	4,650,000	10,000,000	3,000,000
Breakwaters and jetties	Lin ft.	10,500	21,000	15,000

Maintenance would consist of maintenance dredging of navigation features and other water areas and maintenance of protective structures. It is estimated that the quantities of annual average maintenance dredging and sand-bypassing required to maintain the existing and potential small craft navigation facilities would be as follows:

Total cubic yards

	1965	1980	2000	2020
Federal	300,000	320,000	500,000	670,000
Non-Federal	180,000	240,000	280,000	360,000
Total	480,000	560,000	780,000	1,030,000

Order-of-magnitude estimates of first-costs and operation and maintenance for required navigation improvements were based upon historical cost trends, costs for typical existing facilities, average unit costs for dredging and breakwater construction, and existing preliminary cost estimates adjusted to 1965 price levels. Bases for cost estimates and for cost allocations are set forth in the Regional Summary.

Estimated future costs would be as follows:

Summary of first costs

Feature	1966-1980 (millions)	1981-2000 (millions)	2001-2020 (millions)
Commercial navigation	0	0	0
Recreational navigation			
Federal	$8.1	$10.7	$9.1
Non-Federal	23.6	25.9	14.4

Summary of annual maintenance costs

Feature	1980 (millions)	2000 (millions)	2020 (millions)
Commercial navigation	0	0	0
Recreational navigation			
Federal maintenance	$1.0	$1.5	$2.0
Non-Federal maintenance	0.7	0.8	1.1

CENTRAL COASTAL SUBREGION

TABLE CC-1

Summary of Waterborne Commerce[1/], 1965-2020

Type of Commerce	1965[2/]	1980	2000	2020
Foreign exports				
General cargo	0	140	140	140
Total, exports	0	140	140	140
Foreign imports				
Total, imports	0	0	0	0
Coastwise shipments				
Crude petroleum	5,890	6,490	6,610	6,630
Petroleum products	461	460	460	460
Total, shipments	6,351	6,950	7,070	7,090
Coastwise receipts				
Crude petroleum	34	20	20	20
Petroleum products	1,019	1,060	1,060	1,070
Fish and shellfish	19	20	30	30
Total, receipts	1,072	1,100	1,110	1,120
Total Commerce [3/]				
Crude petroleum	5,924	6,510	6,630	6,650
Petroleum products	1,480	1,520	1,520	1.530
Fish and shellfish	19	20	30	30
General cargo	0	140	140	140
Grand total, subregion	7,423	8,190	8,320	8,350

1/ Thousands of short tons.
2/ From "Waterborne Commerce of the United States, Part 4", Department of the Army, Corps of Engineers.
3/ Through offshore petroleum terminals and shallow-draft harbors.

CENTRAL COASTAL SUBREGION

TABLE CC-2

Existing and Projected Commercial Navigation Features and Terminal Facilities, 1965-2020

	1965	1980	2000	2020
OFFSHORE PETROLEUM TERMINALS (DEEP DRAFT)				
Navigation features:				
Depth, feet:				
Carpenteria	60	60	60	60
Ellwood	60	60	60	60
Capitan	32	36	45	45
Gaviota	36	36	45	45
Estero Bay	36	36	45	45
San Luis Obispo	32	36	45	45
Terminal facilities:				
Terminals, number	6	6	6	6
SHALLOW-DRAFT FACILITIES[1/]				
Terminal facilities:				
Terminals, number	5	7	7	7

1/ Navigation features of recreational harbors would be adequate for shallow-draft commercial use.

CENTRAL COASTAL SUBREGION

TABLE CC-3

Recreational Navigation Needs, 1965-2020

	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	2.5 1/	3.8	5.0	5.5
Subregion population, thousands	687	1,066	2,080	4,063
Number of berths needed	1,720	4,000	10,400	22,000
Trailered boats				
Number of trailered boats using navigable waters	2,200	4,600	12,800	30,500
Number of peak-day launchings	475	1,000	2,800	6,600
Launching facilities needed 2/	35	50	85	140
Transient boats				
Number of peak-weekend overnight transient boats	350 3/	750	2,000	5,000

1/ Under existing conditions (1965) actual ratio is 2.1, reflecting constraint of insufficient berthing facilities on berthed boat ownership.

2/ Launching lanes 12 feet wide or hoists. Includes lanes required for adequate access and to serve micro-tributary areas.

3/ Under existing conditions (1965) peak-weekend recreational boats number less than 50. Transient use is constrained by lack of facilities, including a chain of harbors of refuge.

CENTRAL COASTAL SUBREGION

TABLE CC-4

Berthing Capacity of Existing, Programmed and Projected Facilities, 1965-2020

	Berthing Capacity			
	1965	1980	2000	2020
1. EXISTING FACILITIES (1965)				
Federal projects:				
Santa Barbara Harbor[1/]	565	700	700	700
Port San Luis	0	0	0	0
Morro Bay Harbor	175	300	300	300
Monterey Harbor	350	350	350	350
Moss Landing Harbor	50	50	50	50
Santa Cruz Harbor	360	360	360	360
Subtotal, Federal	1,500	1,760	1,760	1,760
Non-Federal improvements:				
None.				
TOTAL, EXISTING FACILITIES[2/]	1,500	1,760	1,760	1,760
2. FACILITIES PROGRAMMED FOR CONSTRUCTION (1965)[3/]				
Federal projects:				
Santa Barbara Harbor Expansion		1,000	2,000	2,000
Port San Luis Harbor Expansion		500	1,000	1,500
Santa Cruz Harbor Expansion		500	500	500
Subtotal, Federal		2,000	3,500	4,000
Non-Federal improvements:				
None.				
TOTAL, PROGRAMMED FOR CONSTRUCTION		2,000	3,500	4,000

See footnotes at end of table.

Continued.

CENTRAL COASTAL SUBREGION

TABLE CC-4

Berthing Capacity of Existing, Programmed and Projected Facilities, 1965-2020 (Cont.)

	Berthing Capacity			
	1965	1980	2000	2020
3. PROJECTED FACILITIES NOT PROGRAMMED				
Federal projects				
Santa Barbara County		0	0	1,000
San Luis Obispo County		0	500	2,700
Monterey County		0	450	2,200
Santa Cruz County		0	2,650	6,150
Subtotal, Federal		0	3,600	12,050
Non-Federal improvements				
Santa Barbara County		240	1,540	4,190
San Luis Obispo County		0	0	0
Monterey County		0	0	0
Santa Cruz County		0	0	0
Subtotal, non-Federal		240	1,540	4,190
TOTAL PROJECTED FACILITIES NOT PROGRAMMED		240	5,140	16,240
GRAND TOTAL	1,500	4,000	10,400	22,000

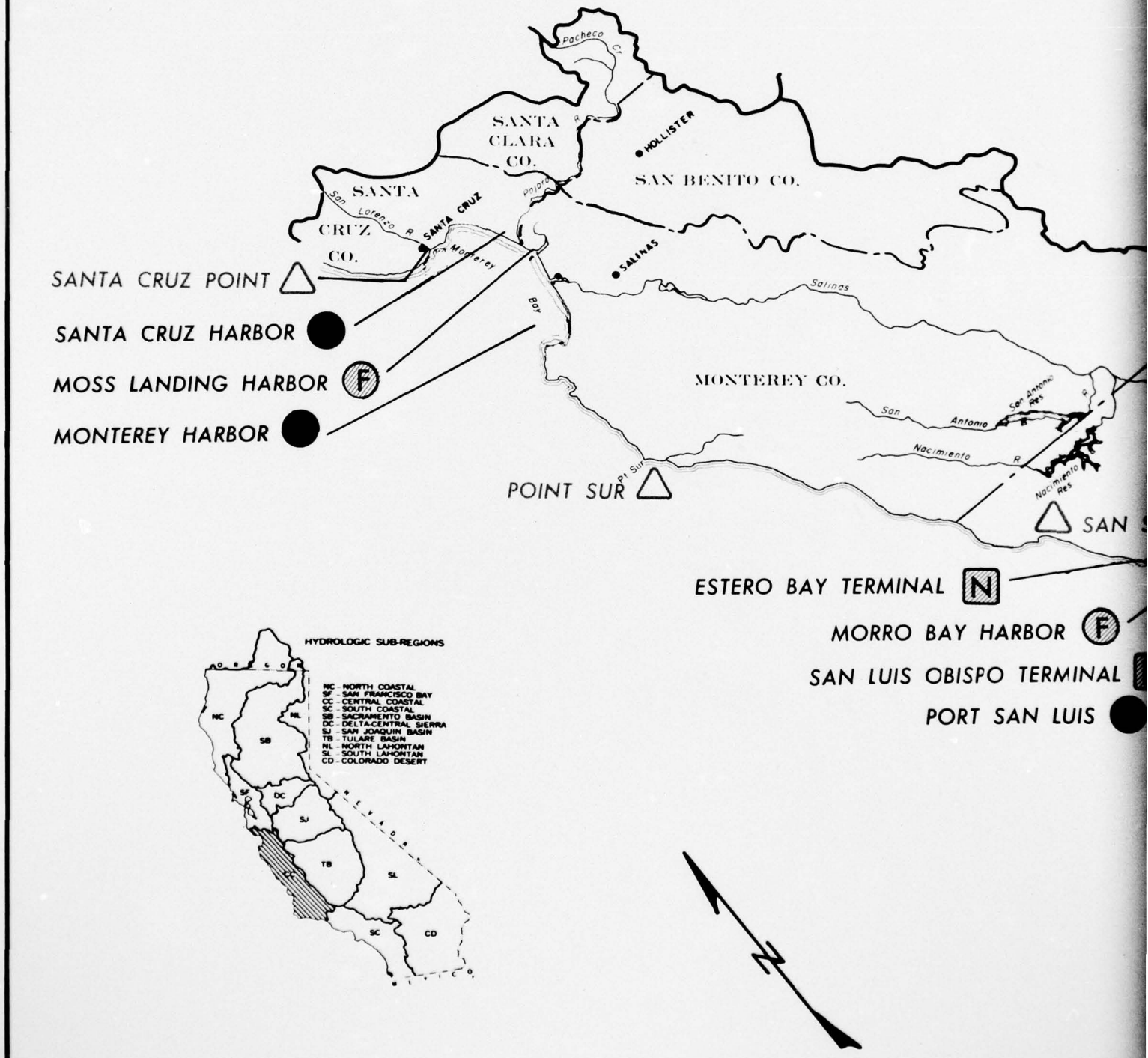
1/ Santa Barbara Harbor was constructed by local interests, but is a Federal maintenance project.
2/ Not including about 250 unsafe or substandard facilities.
3/ Authorized Federal project, non-Federal and private improvements under construction.

CENTRAL COASTAL SUBREGION
TABLE CC-5

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	1,720	2,280	4,000	6,400	10,400	11,600	22,000
Needs met:							
Within facilities existing in 1965 1/	1,500	260	1,760	0	1,760	0	1,760
Within facilities definitely programmed in 1965	0	2,000	2,000	1,500	3,500	500	4,000
Within projected facilities not programmed in 1965	0	240	240	4,900	5,140	11,100	16,240
Incremental additions		2,500		6,400		11,600	
TOTAL	1,500		4,000		10,400		22,000
Residual un-met needs	220		0		0		0
Launching lanes							
Needs	35	15	50	35	85	55	140
Needs met:							
By lanes existing in 1965	35	0	35	0	35	0	35
By projected lanes	0	15	15	35	50	55	105
Incremental additions		15		35		55	
TOTAL	35		50		85		140
Residual un-met needs	0		0		0		0
Transient moorings							
Needs	350	400	750	1,250	2,000	3,000	5,000
Needs met:							
By moorings existing in 1965	200	0	200	0	200	0	200
By projected moorings	0	550	550	1,250	1,800	3,000	4,800
Incremental additions		550		1,250		3,000	
TOTAL	200		750		2,000		5,000
Residual un-met needs	150		0		0		0

1/ To be developed through self-liquidating improvements not included in cost estimates.


Pacheco Cr.
SANTA CLARA CO.
HOLLISTER
SAN BENITO CO.
SANTA CRUZ CO.
San Lorenzo R.
SANTA CRUZ
Pajaro R.
Mouth of Monterey Bay
SALINAS
Salinas R.
SANTA CRUZ POINT
SANTA CRUZ HARBOR
MOSS LANDING HARBOR
MONTEREY HARBOR
MONTEREY CO.
San Antonio R.
San Antonio Res.
Nacimiento R.
Nacimiento Res.
POINT SUR
Pt Sur
SAN
ESTERO BAY TERMINAL
MORRO BAY HARBOR
SAN LUIS OBISPO TERMINAL
PORT SAN LUIS
HYDROLOGIC SUB-REGIONS
NC - NORTH COASTAL
SF - SAN FRANCISCO BAY
CC - CENTRAL COASTAL
SC - SOUTH COASTAL
SB - SACRAMENTO BASIN
DC - DELTA-CENTRAL SIERRA
SJ - SAN JOAQUIN BASIN
TB - TULARE BASIN
NL - NORTH LAHONTAN
SL - SOUTH LAHONTAN
CD - COLORADO DESERT
NEVADA
N

2

LEGEND

COMMERCIAL NAVIGATION

EXISTING DEVELOPMENT (1965)

(N) Existing non-Federal oil terminal

POTENTIAL DEVELOPMENT

Existing oil terminal that may require extension

RECREATIONAL N

EXISTING DEVELOPM

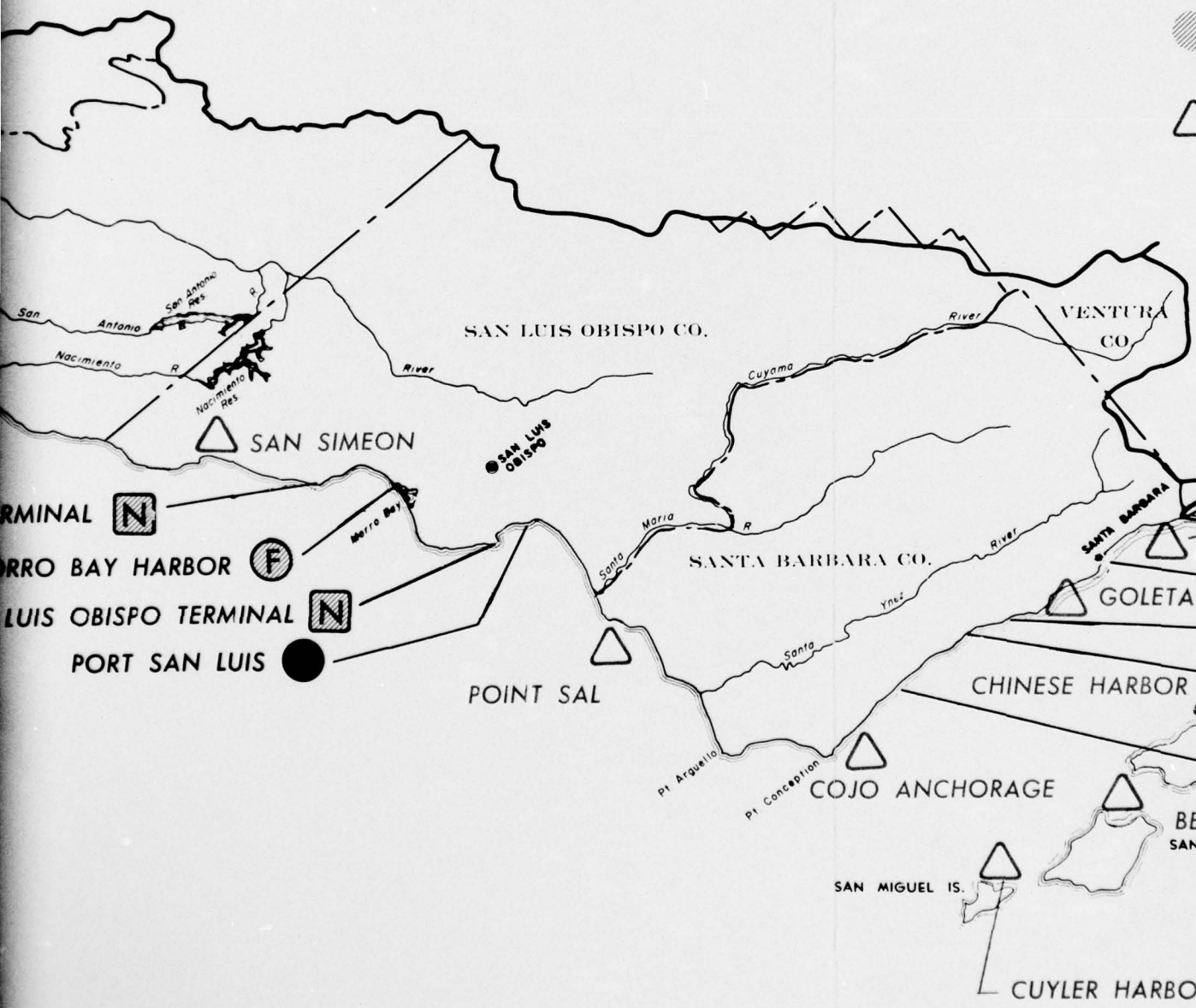
(F) Existing Federa

POTENTIAL DEVELOP

Existing harbor

Existing harbor not programme

Possible site for



3

LEGEND

ERCIAL NAVIGATION

G DEVELOPMENT (1965)

isting non-Federal oil terminal

IAL DEVELOPMENT

isting oil terminal that may require extension

RECREATIONAL NAVIGATION

EXISTING DEVELOPMENT (1965)

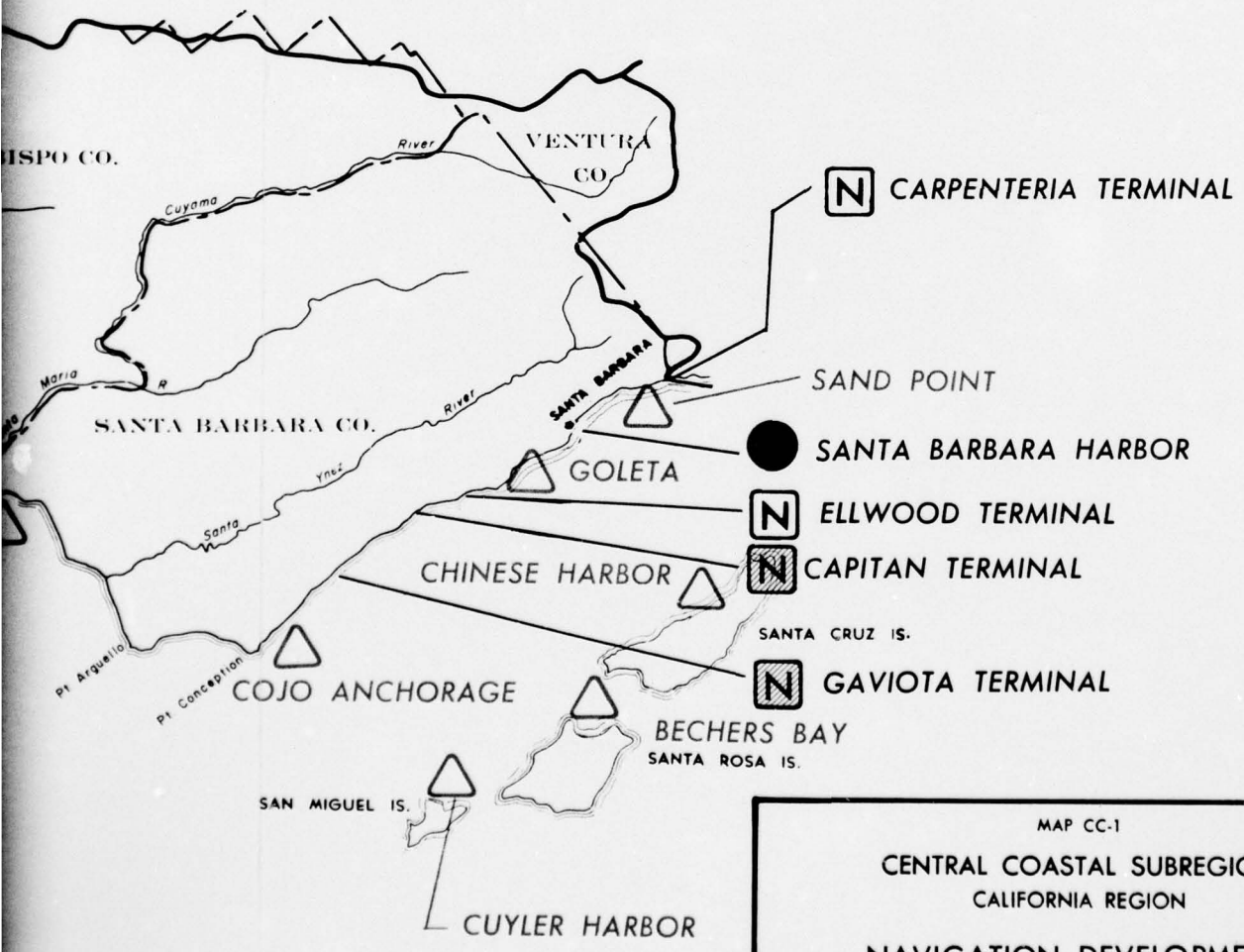
(F) Existing Federal project harbor

POTENTIAL DEVELOPMENT

● Existing harbor programmed for expansion

▨ Existing harbor requiring expansion, not programmed

△ Possible site for harbor to meet future requirements



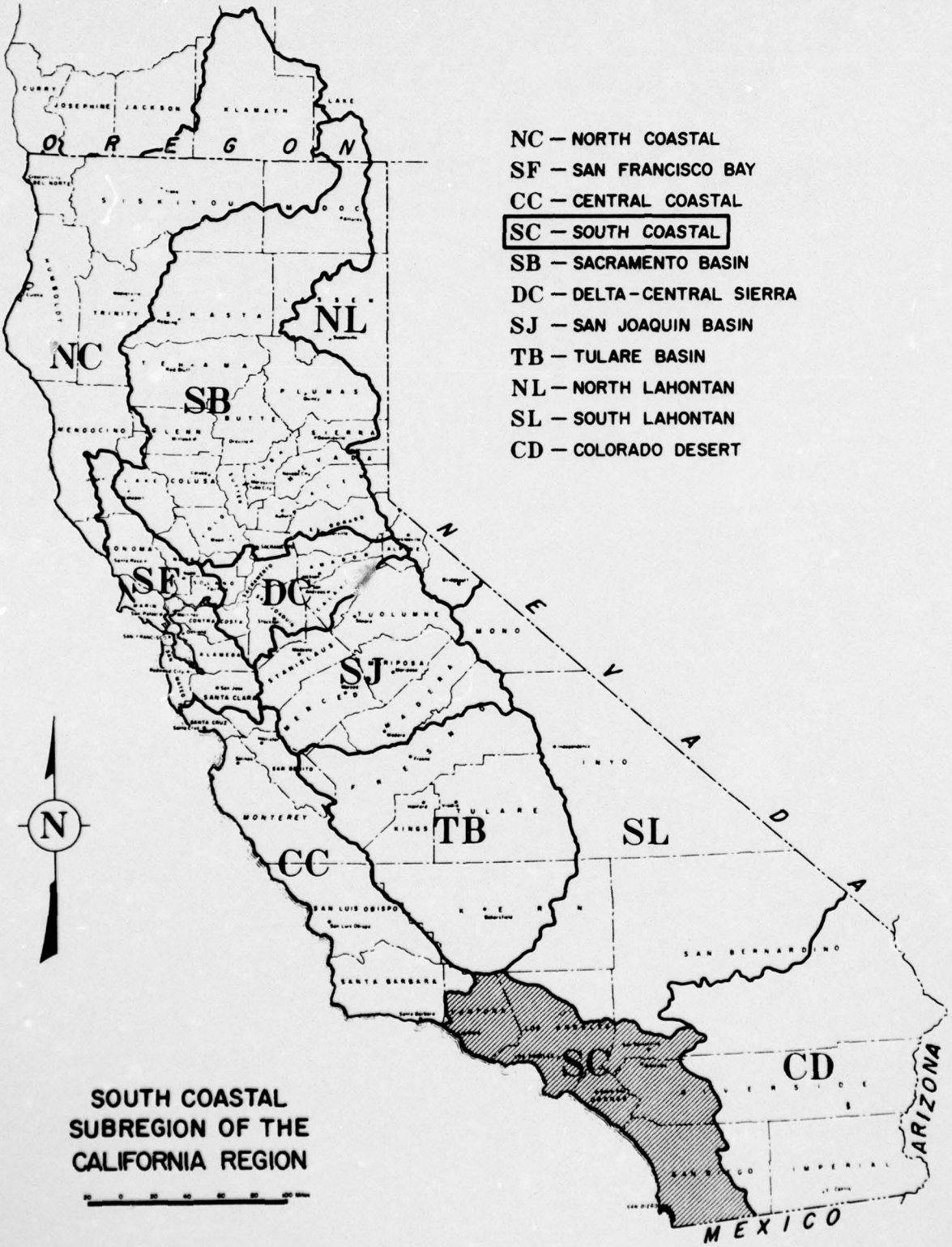
MAP CC-1

CENTRAL COASTAL SUBREGION
CALIFORNIA REGION

NAVIGATION DEVELOPMENT

10 0 10 20
SCALE IN MILES

SOUTH COASTAL SUBREGION



SOUTH COASTAL SUBREGION OF THE CALIFORNIA REGION

SOUTH COASTAL SUBREGION

General

The South Coastal subregion occupies the extreme southwestern part of the Region and extends from the Pacific Ocean to the divide of the coastal ranges: and from the California-Mexico boundary north to near the Ventura-Santa Barbara County line. The subregion is described in detail in Appendix II. The South Coastal subregion contains over one-half of the Region's population. Because of its desirable climate and other favorable factors such as location, transportation, and harbor facilities, the area has experienced very intensive growth in population and industry. Economic activities are diverse and include agriculture, finance, mineral production, manufacturing and foreign, retail and wholesale trade.

The subregion has only one large natural bay, San Diego Bay, and no navigable rivers or inland waterways; commercial and recreational navigation facilities are largely man-made. The Federal cost for deep- and shallow-draft navigation improvements in the subregion, exclusive of the U. S. Navy expenditures, has amounted to about $63 million for construction and $11 million for maintenance.

The fine natural harbor at San Diego is isolated from the interior by mountains. The geography of inland trade routes has favored the growth of the Los Angeles area as the commercial center of southern California. One of the largest man-made ports in the world, Los Angeles-Long Beach harbors, has been constructed to serve this commercial complex.

One-third of all the waterborne commerce of California passes through the ports of the South Coastal subregion: over 30 percent of the waterborne commerce of California passes through the Los Angeles-Long Beach harbors. This port handled almost 33,000,000 tons of waterborne commerce in 1965, representing a monetary benefit to the community of over $263 million.

Landward, the ports of the subregion serve the southwestern quarter of the United States and northern Mexico. Seaward, the ports draw commerce from over half of the world. Over 90 percent of the commerce is derived from, or used within, the southern half of the California region.

In 1965, commercial fish landed in the subregion amounted to 280,000 tons and represented about 80 percent of the fish landed in the California region.

The navigable waters of the South Coastal subregion have been used for recreational boating since the founding of the San Diego Yacht Club in 1886; by 1938, about 6,000 pleasure craft were berthed in the subregion.

In 1965, about 17,600 recreation boats -- 44 percent of all of the recreational boats in the California Region -- were berthed in the coastal harbors of the South Coastal subregion. Over one-quarter of the recreational boats in the California region were owned by residents of coastal Los Angeles County alone. Trailered-boat use of the coastal harbors and launching sites in 1965 is estimated at about 400,000 activity days.

The South Coastal subregion has few inland waters; however, its coastal waters are heavily used for recreational navigation. The ocean is rarely rough enough to be hazardous for small craft; nevertheless, many of the subregion's trailered boats use the inland waters of other subregions, particularly for weekend and vacation use.

Existing Development

COMMERCIAL NAVIGATION

General

Los Angeles-Long Beach harbors function as a single port complex and together account for over 80 percent of the waterborne commerce in the South Coastal subregion. Other deep-draft commercial harbors in the subregion are San Diego Harbor and Port Hueneme Harbor. Port Hueneme Harbor is jointly used by the U.S. Navy and commercial shipping interests. The subregion also has two solely military harbors -- Del Mar Boat Basin, near Camp Pendleton, and the Anaheim Bay Naval Weapons Station Harbor. In addition, there are deep-draft offshore petroleum terminals at Encina (near the town of Encinitas in San Diego County), El Segundo, Huntington Beach, and Ventura. The location is shown on Map SC-1.

Los Angeles-Long Beach harbors and San Diego Harbor are Federal deep-draft navigation projects. Port Hueneme Harbor is a non-Federal public improvement and the offshore petroleum terminals are private improvements. The waterborne commerce of the subregion is summarized in Table SC-1. The existing commercial navigation harbors and improvements are discussed in the following paragraphs.

Los Angeles-Long Beach Harbors

The first Federal work at Los Angeles-Long Beach harbors was authorized by the River and Harbor Act of 1871, which provided for the improvement by the Corps of Engineers of Wilmington Harbor -- now a part of Los Angeles harbor. Numerous and extensive improvements to meet the demands of steadily expanding commerce were authorized by subsequent River and Harbor Acts. The project has been completed except for completion of dredging of East Basin in Los Angeles harbor and is under Federal maintenance by the Corps of Engineers.

Aerial view of a portion of Los Angeles Harbor illustrates the complexity of this man-made harbor. Part of the breakwater protecting the harbor is visible in the upper left.
(Photo courtesy of Port of Los Angeles)

This 35-acre container terminal at the Port of Los Angeles features a 40-ton crane that can load two containers simultaneously in about 3 minutes.
(Photo courtesy of Port of Los Angeles)

The harbors have a protected water area of about 18 square miles, including contiguous outer harbors with anchorage areas protected by more than 8 miles of stone breakwaters, and inner harbors connected by a navigable waterway with an authorized project depth of 35 feet and width of 400 feet. Turning basins and connecting channels in the inner harbors have authorized project depths of 35 and 40 feet. The Los Angeles and Long Beach entrance channels have been dredged by local interests to a depth of 52 feet to provide access to supertanker wharfs. Some areas of both harbors have depths of over 40 feet because of subsidence and dredging for borrow material. Traffic through Los Angeles-Long Beach harbors includes almost every class of commodity. The 1965 waterborne commerce was 33,000,000 tons: 19,000,000 tons were foreign, and 14,000,000 tons were domestic. (See Table SC-2). The leading commodities handled in 1965 were crude petroleum, petroleum products, iron ore, iron and steel products, industrial products, and lumber. Data on 1965 vessel traffic reflect over 11,000 trips (including passage inbound and outbound as one trip). The harbors have 137 berths, and about 1,400 acres of cargo-handling area, including transit sheds, warehouses, and open storage areas. Physical data are summarized in Table SC-5.

A major facility of the U.S. Navy occupies the West Basin of Long Beach Harbor. The facility is comprised of the Long Beach Naval Shipyard and U.S. Naval Station and is home port to over 100 ships of the Pacific Fleet. A small adjacent area of Los Angeles Harbor is also occupied by U.S. Navy facilities.

The harbors also berth commercial fishing vessels and about 3,400 pleasure craft. Los Angeles Harbor is the only regularly scheduled port of call for passenger vessels south of San Francisco. In 1965, about 530,000 passengers embarked and disembarked at Los Angeles; however, 90 percent of these passengers were carried aboard the excursion ship to Santa Catalina Island. The remaining 48,000 passengers were carried on about 510 passenger or cargo-passenger vessel arrivals at the port. The Federal first costs, through 1 July 1965, for the existing project exceed $32 million. The Federal government has spent nearly $3 million for maintenance. An additional $409 million has been spent by local and private interests for port development, ancillary facilities and maintenance.

Preliminary plans prepared by the two harbors propose extensive development to meet expanding needs by filling areas of the outer harbor to form moles and basins. A major expansion into the outer harbor, Pier "J", was completed by the Port of Long Beach in late 1964. It was estimated that Pier "J" would satisfy growth needs of the Port of Long Beach until 1975, but the facility reached saturation by 1970. The Corps of Engineers is presently conducting a study to determine the need for further improvement of both harbors.

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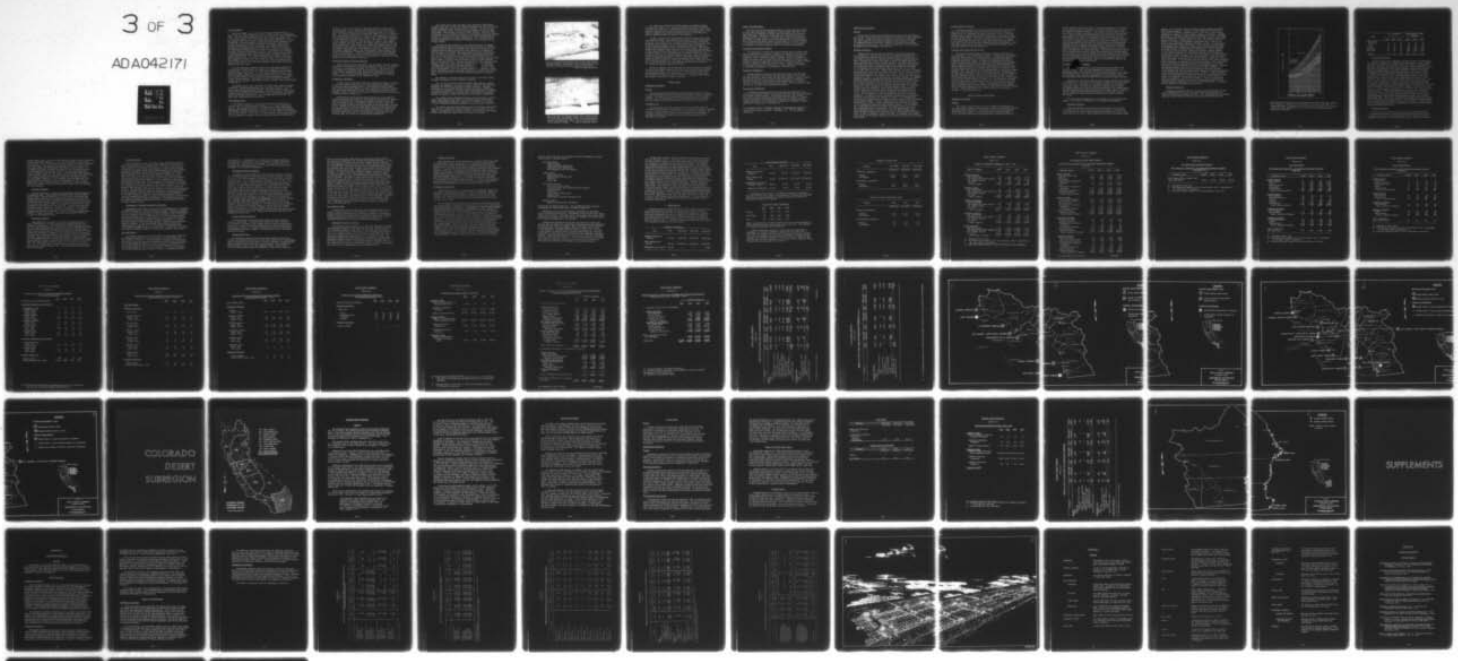

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San Diego Harbor

San Diego Harbor, with a water area of about 18 square miles, is used by the U.S. Navy, commercial vessels, fishing boats and recreational craft. San Diego Harbor contains one of the largest U.S. Navy establishments in the United States. Navy requirements are largely responsible for the character and extent of the existing navigation improvements. Federal improvement of San Diego Harbor, authorized by the River and Harbor Act of 1852, was the first Federal navigation improvement in California. Numerous improvements to meet the demands of expanding commerce were authorized in subsequent River and Harbor Acts. About 97 percent of the improvements authorized prior to 1968 were completed; the remaining 3 percent consisted of additional dredging. The 1968 River and Harbor Act deleted the uncompleted parts of the existing project and authorized further improvements, which are discussed under the heading "Means to Satisfy Future Needs". As of 1965, channels used by naval vessels had been dredged to a depth of 42 feet by the U.S. Navy. The turning basin had a project depth of 35 feet, the anchorage areas had project depths ranging from 26 to 35 feet, and other channels in the harbor had project depths of 20 and 30 feet.

The 1965 waterborne commerce through San Diego Harbor amounted to 1,509,000 tons in 1965, about 4 percent of the waterborne commerce in the subregion. (See Table SC-3). Principal commodities were petroleum products, potash, and lumber. In 1965, vessel traffic was about 1,600 trips (including passage inbound and outbound as one trip). The harbor had 16 berths, about 25 acres of transit sheds and warehouses, and about 2 acres of open storage. The harbor also berthed commercial fishing vessels and an estimated 1,500 pleasure craft. Physical data are summarized in Table SC-5.

The Federal first costs, excluding U.S. Navy costs, amount to about $9,400,000. The Federal government has spent about $660,000 for maintenance of the general navigation features. The Navy has spent about $45,000,000 for navigation improvements in San Diego harbor. Local public interests have spent over $30,000,000 for harbor improvements and maintenance, and private interests have spent an additional $22,000,000 for small-craft improvements and maintenance.

Port Hueneme Harbor

Port Hueneme Harbor is a non-Federal improvement constructed in 1939 and 1940 by the Oxnard Harbor District. As a wartime requirement, the U.S. Navy acquired the harbor by condemnation in 1942, adding more wharfage and terminal facilities. In 1947, the Navy leased the wharfage and terminal facilities originally constructed by the Oxnard Harbor District back to the District. Since 1947, the Oxnard Harbor District has conducted limited commercial operations served by navigable waterways administered

by the U.S. Navy. The harbor is a man-made landlocked harbor with a protected water area of about 80 acres connected to the open sea by a jetty-protected entrance channel with controlling depths of 40 and 36 feet. The harbor interior has a controlling depth of 32 feet. Physical data are summarized in Table SC-5. The U.S. Navy facilities are used for military cargo destined to the Pacific area. Non-military waterborne commerce amounted to 103,000 tons in 1965. (See Table SC-4). Traffic to the commercial terminal in that year was 62 vessels. The leading import commodity has been lumber; the leading export commodity has been diatomaceous earth. Port Hueneme lies within the tributary area of Los Angeles-Long Beach harbors. The area within which Port Hueneme is able to compete successfully with these harbors, because of transportation advantages, comprises parts of the South Coastal, Central Coastal, and Tulare Basin subregions. Commercial operations presently are hampered by lack of facilities. A Federal navigation project for Port Hueneme Harbor has been authorized; the plan of improvement is contained in House Document 362, 90th Congress, 2d session.

Deep-draft Offshore Petroleum Terminals

Private interests have constructed four deep-draft offshore terminals consisting of pipelines for transfer of petroleum products. The depths of water at the terminals vary from 40 to 58 feet. (See Table SC-5). The terminals at Huntington Beach and El Segundo (see Map SC-1) both handle foreign and domestic crude petroleum in addition to petroleum products. The offshore petroleum terminals handled almost 15 percent of the waterborne commerce of the subregion in 1965.

RECREATIONAL NAVIGATION

In 1965, about 17,600 small craft were permanently berthed or moored in the South Coastal subregion in 8 existing small-craft harbors, and in marinas within deep-draft harbors. One additional coastal small-craft harbor, Dana Point Harbor, is under construction, and will provide some small-craft facilities in 1971. The location of the harbors and marinas is shown on Map SC-2; the number of existing berths in each harbor or marina is given in Table SC-7.

Trailered-boat facilities are located within all of the existing small-craft harbors and at many of the marinas within deep-draft harbors. Launching facilities are also located on about 10 coastal piers, and along the shores of bays. Facilities consist of hoists or ramps for placing trailered small craft into the water and of dry-storage, or space where a trailered boat may be stored ashore near the launching facility. An inventory made by the State of California Department of Harbors and Watercraft indicates that there were about 325 "equivalent lanes" of launching facilities in 1965 -- an equivalent lane consists of a 12-foot-wide ramp, or a hoist with equal launching capability.

The Federal first costs for small craft navigation improvements, through 1 July 1965, in the South Coastal subregion were over $22 million; Federal maintenance work has cost almost $2 million. In recent years, annual maintenance costs, exclusive of sand bypassing solely for beach nourishment, have amounted to about $120,000 annually. Required local cooperation in the navigation features of the Federal projects has amounted to about $42 million, and local interests have spent an additional $35 million in non-revenue-producing improvements. The revenue-producing private investment in the harbors is estimated to be in excess of one billion dollars.

The boats presently berthed in the coastal harbors in the South Coastal subregion are almost entirely derived from within the subregion. A detailed survey made in 1967 showed that less than 2 percent of the berthed boats were owned by persons living outside of the subregion. Over one-half of the berthed boats were owned by persons living within 10 to 15 miles of a harbor. The tributary area generating trailered-boat use of South Coastal marine facilities varies according to the type of use; 75 percent of the total use of marine facilities by trailered boats consists of one-day use and originates from the same tributary area as the berthed boats. Weekend use and vacation use, together representing 25 percent of total use, are generated from a more extensive tributary area. The median distance traveled on[illegible]r recreation is generally estimated at about 100 miles for we[illegible] and 150 to 200 miles for vacations. Thus, the Colorado Desert, So[illegible] Lahontan, Tulare Basin, and Central Coastal subregions contribute to weekend and vacation use of marine facilities in the South Coastal subregion by trailered boats.

The adequacy of existing small-craft harbors in the South Coastal subregion is affected by the following conditions:

(1) In 1965, two of the existing harbors were subject to severe shoaling that resulted in difficult entrance conditions, and could not, therefore, be considered all-weather harbors of refuge. Entrance conditions at one of these harbors are being modified by construction of a detached breakwater. The other harbor was authorized as a Federal maintenance project in 1965, and the Corps of Engineers is conducting studies to determine whether modification of the harbor is justified.

(2) Access to one recreational boating area is through a military harbor where munitions are loaded; use of this entrance by pleasure craft is potentially dangerous. The Corps of Engineers is conducting a study to determine whether improvements in this area are justified.

(3) Use of Los Angeles-Long Beach harbors by pleasure craft causes some concern to commercial shipping operating in the channels of the harbors. Relocation of the pleasure craft to other areas is not contemplated until additional small-craft facilities are provided.

Mission Bay Harbor and Aquatic Park, in San Diego County, provides almost 2,000 acres of protected water area for recreational boating and other water-oriented sports.
(Corps of Engineers photo)

Marina del Rey, Los Angeles County, will provide berths for about 6,000 recreational boats. This photograph was taken on New Years Day, 1970; notice the boat traffic in the entrance channel. (Corps of Engineers photo)

(4) There are reaches of coastline between all-weather harbors of more than 35 miles -- the spacing considered desirable for harbors of refuge for small craft. Completion of the Federal small-craft harbor project at Dana Point in 1969 has eliminated one of these reaches. The Corps of Engineers is presently conducting a study to determine the need for further harbors of refuge in the subregion.

In 1965, facilities for permanently berthed and moored small craft totaled about 17,600. The number of berths needed in 1965 is estimated at 24,000. (See Table SC-6). Facilities within existing harbors are generally fully occupied within a short period after construction. Most of the small-craft harbors in the subregion are fully developed and cannot provide additional berthing or mooring facilities. Many of the existing 325 launching units were found to be structurally substandard, to have restrictively limited parking, or to be unserviceable to a greater or lesser degree. It is estimated that the existing facilities are equivalent to about 200 effective launch ramp lanes, which is an adequate number to meet existing demand. However, additional coastal launching sites are needed to provide access to desirable fishing areas and to relieve localized heavy use. The Corps of Engineers is presently conducting a study to determine the justification for providing protection for additional coastal launching facilities.

Berths or moorings for temporary use by cruising boats are available at most of the coastal harbors. The destination for about seven-eighths of the cruising boats in the subregion is Santa Catalina Island, which has moorings available for temporary use. It is estimated that peak-period demand for temporary use of facilities by cruising boats exceeds the supply of facilities by about 25 percent.

Future Needs

COMMERCIAL NAVIGATION

General

The future needs for commercial navigation were assessed in terms of projected waterborne commerce tonnages considered in terms of commodity classes. The bases for the projections are discussed in the following paragraph, and the projections for Los Angeles-Long Beach, San Diego, and Port Hueneme harbors are contained in Tables SC-2, SC-3 and SC-4.

Tributary Areas

Tributary areas for Port Hueneme and San Diego harbors had been developed in detail during studies made by the Corps of Engineers, published as part of House Documents 362 and 365, 90th Congress, 2d session. The tributary areas for Los Angeles-Long Beach harbors and the offshore petroleum terminals were developed from preliminary studies made by the Corps of Engineers.

Traffic and Commodities

For San Diego and Port Hueneme harbors, for which detailed studies had been made, projections developed in those studies were used. The projections were modified to reflect Base Plan population projections where applicable. Generally, imports through a harbor were based on consumer needs of the harbor's tributary area population; and exports were based on demand factors in the destination area. The projections for Los Angeles-Long Beach harbors are discussed in more detail because the rationale used has not been previously published. This rationale is discussed by general commodity class in the following paragraphs.

Petroleum and Petroleum Products

The projections of demand for crude petroleum foreign imports were based on population and personal income in the immediate tributary area. Potential local oil production was considered. Foreign exports were projected to have a nominal increase, primarily due to an increase in demand for bunker fuel to service the continual growth in foreign trade. Coastwise receipts of petroleum products were projected from past economic growth, at about the same rate as in the past. Coastwise shipments of petroleum products were projected at a slight upward trend because of continuing development in the immediate tributary area.

Industrial Commodities

Foreign exports projections were based on growth rates developed for San Diego Harbor, as most of the industrial export trade is with the same countries, namely Japan and other Asian nations. Foreign imports projections were based on the growth rates contained in "Resources in America's Future"1/ and Base Plan population projections. Coastwise receipts and shipments were based on past trends, indicated future consumption or use, and Base Plan population projections.

Agricultural Commodities

Projections of foreign exports for agricultural commodities were based on raw materials demand rate developed for the ECAFE Nations supplied by southern California ports. A weighted growth rate was developed for export of fruits and vegetables because most of these go to western Europe. Projections of foreign import agricultural commodities were principally based on rates developed in "Resources in America's Future," adjusted for population in tributary area.

1/ Landsberg, Hans H., Fischman, Leonard L., and Fischer, Joseph L., "Resources in America's Future". Baltimore, Md.: The John Hopkins Press, 1963

RECREATIONAL NAVIGATION

General

Projections of future boat ownership were based on the methodology used in the "California Small-Craft Harbors and Facilities Plan, Comprehensive Report," dated March 1964, prepared for the State of California. The future needs for recreational navigation were assessed in terms of permanent berthing facilities, launching facilities, and transient and destination facilities. These needs are discussed in the following paragraphs and are summarized on Table SC-6.

Berthing Facilities

Present and projected needs for berthing facilities were based upon evaluation of the positive effects of increased disposable income on berthable-boat ownership and the negative effects of congestion. The relative proportion of berthable to non-berthable boats was reduced about 10 percent per decade after 1980 to reflect congested berthing areas, higher berthing costs, crowded waterways, and other factors that would make this type of boating less desirable. Applying these factors, the theoretical ratio of berthable boats to population was estimated at 2.4 berthable boats per thousand population in 1965, 3.4 in 1980, 4.7 in 2000, and 5.0 in 2020. These ratios are valid in terms of present experience and, indeed, are far lower than existing 1965 ratios of berthable-boat ownership in many parts of the country. Areas of Florida and the Pacific Northwest, for instance, had 7.5 berthable boats per thousand population in 1965. In the South Coastal subregion, applying the computed ratios to population projections resulted in a theoretical demand for berths for about 119,000 boats by the year 2020, at 5.0 berthable boats per thousand population. The shoreline of the subregion was analyzed with a view toward developing the maximum feasible number of facilities, allowing for other necessary and desirable shoreline uses. It became apparent that the theoretical demand would require a transformation of the subregion's shoreline into a virtually continuous small-craft harbor. This single-purpose aquatic congestion, in itself, was felt to be a strong deterrent to full development of this form of boating recreation. A tentative plan was developed recognizing the limitations resulting from feasibility of meeting the needs. It is acknowledged that the plan of development of berthing facilities would tend to constrain berthed-boat ownership. About 70 percent of the demand for berthing was being met in 1965. By 2020, satisfaction of only about 67 percent of the theoretical demand for berths appears feasible. It was assumed that a substantial part of the demand for berthing would have to be met through some form of dry storage. This dry storage would be for non-trailerable boats, as contrasted to the customary storage areas often provided at marinas for trailered boats. Dry storage for berthable boats, in lieu of berthing, could be provided in structures with pigeonhole storage and mechanical handling and launching facilities for relatively large boats.

Trailered-boat Facilities

The present and projected needs for trailered-boat facilities were based upon the estimated use of ocean waters by trailered boats, as presented in the "Comprehensive Report" previously cited. These data summarize the percentage of trailered boats using the ocean by length and the average number of days use, and were used to estimate the number of peak-day launchings. The peak-day launching criteria -- 50 boats a day launched and recovered by a single equivalent launching lane 12 feet wide -- were used to determine launching facilities required. Land area requirements for dry storage of trailered boats adjacent to the launching areas have not been estimated.

Transient and Destination Facilities

The need for transient and destination facilities was based on data contained in the "Comprehensive Report." Transient and destination facilities would consist of berths, moorings, and anchorage areas for overnight and vacation use by cruising boats and would also provide protected refuge from storms. Transient and destination facilities would include fueling facilities, sanitary facilities and potable water supply, emergency assistance, and boat supply and repair facilities. The estimated annual days of overnight and vacation use away from home port by cruising boats in 1965 totaled about 142,000. In 1965, it is estimated that 3,200 vessels required accommodation on the busiest summer weekend. Data contained in the "Comprehensive Report" indicates that the destination for seven-eighths of the cruising boats in the subregion was Santa Catalina Island. Peak-day overnight use at Santa Catalina Island would therefore amount to about 2,800 overnight uses, which agrees very well with field estimates of actual use. The remaining overnight use by cruising boats is distributed among the coastal harbors and semi-protected coastal anchorages. Future needs, estimated at the present rate of transient use per total number of ocean-going boats, would be about 6,000 peak-day uses by 1980, about 12,000 by 2000, and about 20,000 by 2020. Island destinations will probably continue to attract the majority of the cruising vessels.

Means to Satisfy Future Needs

COMMERCIAL NAVIGATION

General

The means to satisfy future needs for commercial navigation in the South Coastal subregion would consist primarily of expanding existing deep-draft harbor facilities. The needs for facilities for shallow-draft commercial vessels -- primarily commercial fishing vessels -- can be met within deep-draft and shallow-draft harbors and would not

require separate harbor facilities. The existing ports of the subregion can be expanded within their present perimeters sufficiently to handle the projected waterborne commerce. The means to satisfy future needs are defined in terms of required navigation features and terminal facilities. Projected navigation features are given in terms of controlling dimensions and are based on the assumption that vessel waiting-time for favorable tides would be completely eliminated. Projected characteristics of the largest vessels expected to call at the subregion's port and terminal facilities are based on the assumptions that conventional, monohull ships will continue to serve most of the needs of waterborne commerce and that present trends toward larger vessels will continue. Projected cargo was classed by handling technique as liquid bulk, dry bulk, containerized, or break-bulk cargo. Containerized cargo was considered to include all specially handled cargo shipped in homogenous units. In estimating future needs for berths and backup acreage, it was assumed that all commodities would be handled by the most efficient means, limited only by their physical properties, and that land transportation at the ports would function efficiently. Each of the subregion's harbors are discussed in the following paragraphs.

Los Angel[illegible]ng Beach Harbors

Al[illegible]able facilities at Los Angeles-Long Beach harbors were fully [illegible]zed in 1970, and port expansion is urgently needed. An authorized study, being conducted by the Corps of Engineers, is in its preliminary stages. Much of the following plan for meeting future needs has necessarily been developed independent of the authorized study. Two alternative plans were evaluated for Los Angeles-Long Beach harbors.

Alternative 1 considered expansion of navigation features and terminal facilities in the outer areas of the harbors to meet the projected needs to the year 2020. Alternative 2 considered expansion of Los Angeles-Long Beach harbors to handle all waterborne commerce except foreign and Alaskan imports of crude petroleum and extension of El Segundo and/or Huntington Beach offshore petroleum terminal to deeper water, or replacement of these existing offshore terminals with a buoy-type terminal for the receipt of crude petroleum on tankers with drafts in excess of 50 feet.

The plan, under Alternative 1, is discussed in the following paragraphs. The effects of Alternative 2 are discussed subsequently.

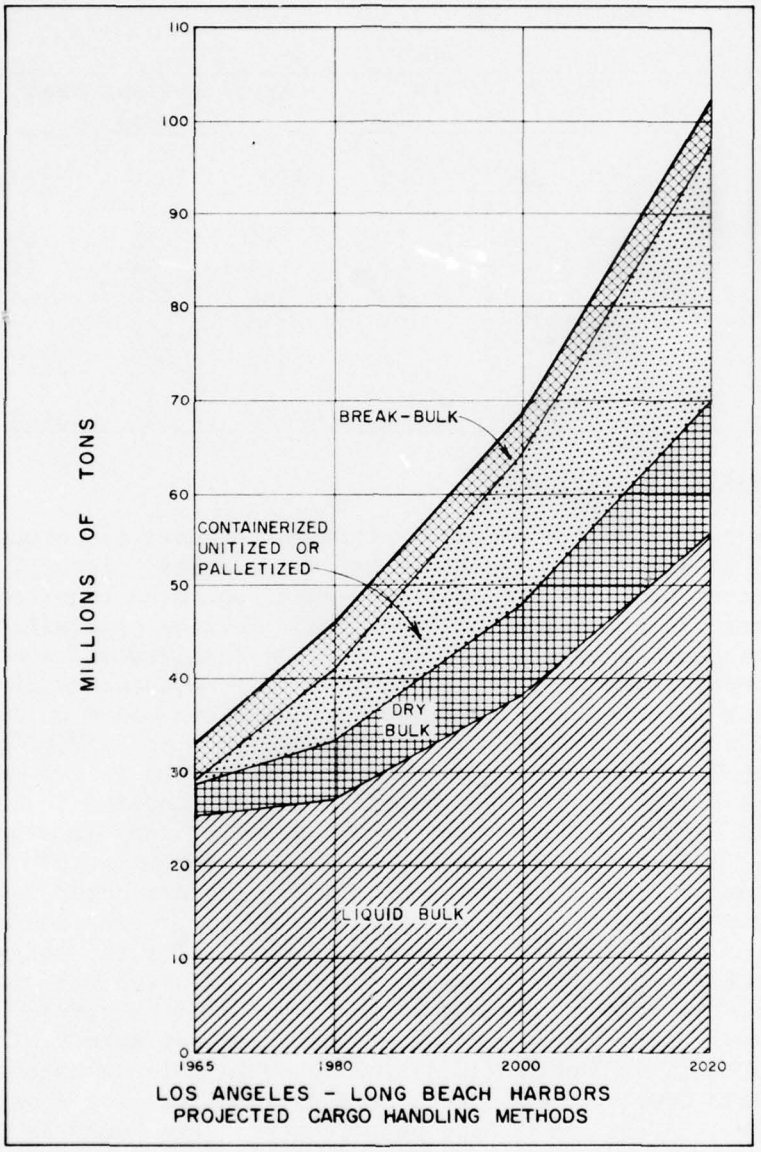
Navigation Features

Studies to develop a master plan for improvement of Los Angeles-Long Beach harbors are presently being made by the Corps of Engineers in cooperation with the Los Angeles Harbor Department, the Port of Long Beach, and the U.S. Navy. These studies are in their preliminary stages;

however, it is indicated that all present project channels and basins will require deepening or widening and that additional channels and basins will be required. Removal of about 1,000 feet of the existing breakwater to create a new and separate entrance is proposed. Channels and basins in the inner harbors would be deepened to 42 feet to accommodate a tanker with a loaded draft of 39 feet. The minimum channel width would be 400 feet. Entrance channels to both outer harbors would be deepened to 68 feet to accommodate a supertanker with a draft of 60 feet, by 1980 and further deepened to 80 feet, by 2000, to accommodate a supertanker with a draft of 70 feet. Other channels, turning basins, and anchorage areas required for supertankers would require deepening to 65 and 75 feet, in 1980 and 2000, respectively. Entrance channels of these depths would require dredging of approach channels seaward of the existing breakwaters. The material dredged from channels and basins would be used to create land fills for terminal facilities between the existing land in the harbor and the breakwaters. About 90 million cubic yards would be obtained from dredging project channels and basins by the year 2000. It is estimated that 190 million cubic yards of material would be required to construct the required land area. About 100 million cubic yards would be borrowed seaward of the breakwaters -- an ample quantity to achieve construction of required approach channels. Existing and projected channel and basin dimensions are shown in Table SC-5. Los Angeles and Long Beach harbors are separate political entities; it was assumed that the two harbors would continue to maintain competitive status by providing equivalent facilities. However, it was determined that a single extreme-draft navigation channel to a supertanker terminal, either in Los Angeles or Long Beach harbor, could enable the port to handle the projected crude petroleum tonnage. There are indications that the channels leading to the existing supertanker terminal in Los Angeles harbor are underlain with rock or rock outcroppings. Relocation of this facility would probably be required.

Terminal Facilities

Estimates of required terminal facilities were considered in terms of the minimum number of berths and cargo-handling area required to handle the projected waterborne commerce. The commodities were distributed among the various handling methods, as shown on the following graph.



LOS ANGELES - LONG BEACH HARBORS
PROJECTED CARGO HANDLING METHODS

The resulting terminal facility requirements were based on normal, probable berth occupancy, capacity of design vessels of various types, and, in certain instances, continuance of present competitive practices. Terminal requirements were determined to be as shown in the following tabular summary and discussion.

Type	No. of berths			Cargo-handling area (acres)		
	1980	2000	2020	1980	2000	2020
Liquid bulk:						
Petroleum	9	11	13	45	55	65
Other	2	2	2	15	15	15
Dry-bulk	12	14	16	360	420	480
Container	17	25	42	830	1,260	2,490
Break-bulk	35	35	35	350	350	350
TOTAL	75	87	108	1,600	2,100	3,400

Liquid Bulk Terminals

The major liquid bulk commodities through the port are crude petroleum products, molasses, and vegetable and animal oils. About 2 berths, with about 8 acres of cargo handling area each, would be required for molasses. Vegetable and animal oils would not require specialized liquid bulk facilities because of the nominal tonnages involved and would be handled at general cargo or dry-bulk terminals. Projected terminal requirements for petroleum and petroleum products are based on import of foreign crude by 200,000 DWT supertankers in 1980 and 350,000 DWT supertankers in 2000 and 2020. Two supertankers berths in the outer harbor would be needed in 1980 and an additional two berths in 2000 and 2020. Each berth would require about 5 acres of support area. Domestic crude is expected to arrive in 47,000 DWT tankers to terminals in the inner harbor areas by 1980. About 1990, the projected volume of domestic crude receipts would generate a need for relocation of domestic crude to terminal facilities in the outer harbors. For the years 2000 and 2020, domestic crude supertankers of 200,000 DWT were used to project terminal needs. Petroleum products would continue to be carried by 47,000 DWT vessels, primarily because of the hazardous nature of the commodities. The inner harbor facilities would be able to handle the combined domestic crude and petroleum products tonnage over 7 berths until about 1990. After 1990, only petroleum products would be handled, and 7 berths would be required in 2020. Each berth would require about 5 acres of land area for loading facilities and bunkers. Storage facilities for crude petroleum and petroleum products would be located outside of the immediate harbor areas.

Dry-bulk Terminals

In this study, it has been assumed that all commodities moving in sufficient quantities and having suitable physical properties will be handled as dry bulk. At Los Angeles-Long Beach harbors, dry-bulk shipments would consist of iron and steel scrap, iron ore concentrates,

grains, animal feeds, copra, minerals, chemical products, and miscellaneous physically-suitable commodities. In 1965, there were ten bulk loaders in the harbor. Some of these were marginal facilities, handling relatively small quantities. The present bulk-loading facilities at Los Angeles-Long Beach harbors are economically profitable to the operators. It is assumed that future operating methods will resemble present methods and that operators will continue to invest in bulk loaders whenever a more profitable operation will result. This rationale would indicate a need for bulk loaders for each major commodity and duplicate facilities at Los Angeles Harbor and Long Beach Harbor where operators compete for a particular commodity. It is estimated that two additional bulk loaders would be required by 1980, four additional by 2000, and six additional by 2020. Each bulk loader would handle a single commodity; under these conditions about 30 acres per bulk loader would be required for cargo handling.

Container Terminals

The term "container" is used here to include any method of handling pre-packaged cargo. These include palletized cargo, such as lumber; unitized cargo, such as automobiles; and the familiar container vans. Containerized, palletized, and unitized cargoes all can be loaded or unloaded rapidly; all require extensive cargo-handling areas per berth. The average cargo handling capability of a single container cargo berth at Los Angeles-Long Beach harbor is estimated at 500,000 tons in 1980, increasing to 800,000 tons by the year 2020. Projected containerized or unitized cargo tonnages are 8 million, 14 million, and 27 million tons for the years 1980, 2000, and 2020, respectively. In 1980, 17 container berths would be required; in 2000, 25 would be required; and in 2020, 42 would be required. Each berth would require from 30 to 50 acres of cargo-handling area.

Break-bulk Terminals

Some commodities, by reason of excessive dimensions, weight, or other characteristics, are not suitable for containerization, bulk handling or unitization. These commodities comprise break-bulk cargo, and may include miscellaneous items capable of other handling, but moving in such small quantities that specialized handling is not warranted. Trends indicate that break-bulk shipments through Los Angeles-Long Beach harbors will stabilize at between 4 and 5 million tons and, therefore, will represent a steadily-diminishing percentage of the total waterborne commerce. Break-bulk cargo is generally handled in small shipments over unspecialized berths. Loading and unloading is comparatively slow, and only about 10 acres of cargo handling area are required per terminal. Each berth would handle an annual tonnage of from 100,000 to 150,000 tons. It is estimated that 35 general cargo terminals handling break-bulk would be required through 2020. The cargo-handling area required would be 350 acres.

Land Requirements

Land requirements at Los Angeles-Long Beach harbors are based on 1965 estimated land use and projected 2020 land use. The harbors have about 4,000 acres of land, of which about 1,400 acres, or 35 percent, is available for cargo handling and storage. In the future, about 50 percent of the harbors' lands could be made available for cargo handling and storage, assuming that oil production and industrial facilities directly related to oil production are gradually phased out. By the year 2020, about 3,400 acres of cargo-handling area would be needed, which would require a total land area of 6,800 acres - 2,800 acres more than the harbors now have available. Of this additional 2,800 acres, approximately 400 more acres would be needed by the year 1980 and about 400 acres by the year 2000. It is impossible, at this time, to delineate the 'geography' of land development in the harbor; however, it is highly probable that additional land will be created in the outer harbor by filling. The available water area is sufficient to permit this development and still maintain adequate navigation features. As the necessary lands are constructed in the outer harbor, redevelopment and modernization of the inner harbors can proceed. One major modification will most likely be required about 1980 - closure of Cerritos Channel, which connects the inner Los Angeles and Long Beach harbors. This modification will be required to provide necessary expansion of transportation facilities servicing Terminal Island.

Alternative 2, Offshore Supertanker Terminals

Supertankers with extreme draft could be accommodated in the subregion by extension seaward of existing offshore petroleum terminals or construction of a new buoy-type deep-water terminal offshore. Offshore facilities could be extended to deeper water at a fairly moderate cost. No attempt was made to compare costs of Alternatives 1 and 2 for Los Angeles-Long Beach harbors because the required land fill would necessitate dredging for borrow far in excess of channel dredging requirements. In brief, deepening channels would serve both purposes. However, cost allocations would be affected. It has been assumed that dredging for borrow to create land fill would be, as it is at present, a non-Federal cost. If channels were deepened only to 65 and 68 feet through 2020, the Federal cost would be reduced, however no over-all cost reduction would result.

San Diego Harbor

The Federal project for San Diego Harbor, as previously authorized, was modified according to the plan contained in House Document 365, 90th Congress, 2d session. This plan entails deepening, widening, and extending the existing navigation channels and turning basins, and extension of authorized maintenance to include channels or additional depth of channels dredged by the U.S. Navy or local interests, as well as other improvements not pertinent to navigation. The plan, as presented in the House Document, would satisfy the needs for navigation through

the year 2020. In September 1966, the Chief of Engineers authorized reactivation of a study with a view to providing a second entrance to San Diego Bay. This study is in progress. The authorized plan and subsequent improvements necessary to meet the needs for navigation are discussed in the following paragraphs.

Authorized Navigation Features

The authorized plan provides for the following navigation features: (1) an entrance channel 42 feet deep, 800 feet wide and about 2.4 miles long; (2) a navigation channel 42 feet deep, of varying width and about 4.7 miles long; (3) a turning basin 42 feet deep; (4) a Central Bay channel 40 and 35 feet, of varying width and about 4.7 miles long; (5) channels 30 feet deep on either side of the 40-foot deep Central Bay channel; (6) and a South Bay channel 35 feet deep and about 1.5 miles long, with a turning basin 35 feet deep. The 42-foot-deep channels and turning basin have been dredged to that depth by the U.S. Navy. The reach of Central Bay channel recommended for deepening from the existing 33-foot depth to a depth of 40 feet would accommodate a 24,000 DWT bulk carrier with a draft of 34 feet and would allow this prototype vessel access to the 10th Avenue Terminal. The reach of Central Bay and South Bay channel recommended for deepening to 35 feet would accommodate a general cargo vessel of the Mariner class with a draft of 30 feet and would allow this prototype vessel access to the 23rd Street terminal, which is under construction. The Port District plans construction of a 30-foot-deep interior channel to this terminal and proposes future construction of "D" Street Terminal farther down bay. These channels and terminals would be adequate to handle the projected waterborne commerce through the year 2020. Existing and projected facilities are summarized in Table SC-5.

Future Navigation Features

A second entrance to San Diego Bay through the Silver Strand is currently under study. Hydraulic model studies have been completed by the Corps of Engineers: these studies indicate that a second entrance just north of Silver Strand State Beach would not adversely affect the circulation of the bay. A second entrance may prove to have commercial and recreational benefits, however, its feasibility has not been determined at this time.

Terminal Facilities

The projected commodities through San Diego Harbor include those suitable for handling as dry bulk, liquid bulk, palletized or containerized cargo, and general break-bulk cargo. Dry-bulk commodities include alfalfa pellets, potash, iron ore pellets, and scrap steel. These commodities would require a minimum of two bulk loaders through the year 2020. Each bulk loader would handle two commodities; under these conditions,

about 45 acres per bulk loader would be required for cargo handling. The liquid bulk commodities are molasses and petroleum products. A pipeline facility and a storage area of about 5 acres would be required for each commodity through the year 2020. Because the port will operate as a secondary port, in terms of world trade, the tonnage handled over each general cargo berth would probably be relatively nominal and could consist of partial ship loads. General cargo likely to be palletized, unitized, or containerized would comprise plywood, newsprint, lumber, and about 55 percent of the miscellaneous foreign export and import. The minimum number of berths and cargo-handling area required are estimated as follows: year 1980, 2 berths and 40 acres; year 2000, 3 berths and 70 acres; and year 2020, 4 berths and 120 acres. The remaining waterborne commerce would be handled as general break-bulk cargo. The number of break-bulk berths and cargo handling area required are estimated as follows: year 1980, 11 berths and 90 acres; year 2000, 12 berths and 100 acres; and year 2020, 18 berths and 150 acres. The total number of berths of all sorts are, for years 1980, 2000, and 2020 respectively, 17, 19, and 26. The required cargo-handling area is estimated at 245 acres in the year 1980, 275 acres in the year 2000, and 375 acres in the year 2020. About 300 acres of cargo-handling area would be available at the 10th Street, 24th Street and "D" Street terminals. Assuming 50 percent of the total area could be used for cargo handling, about 450 additional acres of terminal area would be required by the year 2020. Additional terminal facilities can be developed on available land in the south bay area.

Port Hueneme Harbor

A Federal plan for the improvement of Port Hueneme Harbor is contained in House Document 362, 90th Congress, 2d session. This plan entails deepening and widening the navigation features of the existing harbor and would satisfy the needs for navigation through the year 2020. Existing and proposed facilities are summarized in Table SC-5. The authorized plan is discussed in the following subparagraphs.

Authorized Navigation Features

The authorized plan provides for the following navigation features: (1) an approach channel 40 feet deep, 600 feet wide, and 800 feet long; (2) an entrance channel 36 feet deep, 330 feet wide, and 1,550 feet long; (3) a central basin 35 feet deep, 1,025 feet wide, and 1,080 feet long; (4) a channel 35 feet deep, 275 feet wide, and 2,830 feet long; and (5) two rubble-mound stone jetties 800 and 1,000 feet long. The navigable waterways were designed to meet the demands of existing and prospective commerce and to accommodate a general cargo vessel of 24,000 DWT with a draft of 32 feet. The approach channel, entrance channel, and jetties would require no construction as these features of the existing harbor meet the requirements of the recommended plan.

Terminal Facilities

Upon completion of the recommended plan, terminal facilities would be constructed by local interests. These terminal facilities would consist of three general-cargo berths, one bulk-cargo berth and one lumber berth. The bulk cargoes would consist of fertilizers and raw chemicals. Lumber would be handled as palletized cargo by barges carrying 1,100 to 2,500 tons. The balance of the waterborne commerce would be handled as break-bulk in shipments not exceeding 500 tons. Break-bulk cargoes would consist of chemical products, diatomaceous earth, cotton, and miscellaneous commodities. The estimated future cargo-handling area would comprise about 50 acres, or about 80 percent of the total 62 acres owned by the Oxnard Harbor District. In view of the relatively minor commerce projected for this port, both the number of berths and acreage of cargo-handling area would be adequate through 2020.

RECREATIONAL NAVIGATION

Future needs can be met by construction of additional harbors and marinas to provide sheltered water for berthing facilities, launching facilities, and transient facilities, including refuge for cruising vessels. The needs for recreational navigation facilities are shown in Table SC-6. Locations of existing and proposed harbors and marinas are shown on Map SC-2.

It was assumed that all existing and programmed small-craft harbors and marinas would be developed to design berthing capacity. These capacities are summarized in Table SC-7. Satisfaction of the remaining berthing demand would be met in facilities not programmed in 1965. About 19,000 additional berths would be made available by 1980; 59,500 additional berths by the year 2000; and 87,500 additional berths by the year 2020. Consideration was given to known conflicts between special shoreline uses and to the physical character of the shoreline. A plan was developed for meeting part of the berthing requirements through conventional berthing facilities. The balance of the demand for storage of berthable boats could be met through specialized dry-storage facilities adjacent to the berthing areas. (See Table SC-8) Some harbor sites selected for future development have been expressly opposed by special interests; however, in light of present property ownerships and legislative constraints, these sites were considered available for harbor development at the present time. It was assumed that all authorized Federal studies with a substantial chance of proving justified would become authorized Federal projects; a berthing capacity for these harbors was estimated.

Specific sites that have been proposed for future development as small-craft harbors or marinas include:

San Diego County:
- Imperial Beach
- Chula Vista (San Diego Bay)
- Oceanside Harbor (Expansion)
- Agua Hedionda or Del Mar Lagoons

Orange County:
- Upper Newport Bay
- Newport Beach offshore area
- Bolsa Bay
- Sunset Bay

Los Angeles County:
- Long Beach offshore area
- Los Angeles-Long Beach Harbors (within harbors)
- Portuguese Bend
- Malaga Cove
- Santa Monica offshore area
- Paradise Cove
- Santa Catalina Island (Isthumus area)

Ventura County:
- Channel Islands Harbor (Expansion)

These sites are shown on Map SC-2. The estimated berthing capacity, by counties, of these harbor sites is given in Table SC-7.

Projected future needs for launching facilities for trailered boats were based on past trends. The number of lanes needed would about double every 20 years. (See Table SC-8) These needs could be met within existing and proposed harbors and marinas, at transient or refuge facilities, within the larger bays, and on piers.

Transient and destination facilities are considered a major and pressing need to permit full realization of boating recreation associated with weekend and vacation cruising. Santa Cruz Island, in the Central Coastal subregion, and Santa Catalina Island are sufficiently close to the subregion's mainland harbors to permit overnight use. The plan of development for Santa Catalina and Santa Cruz Islands would include improvement of coves and bays to afford protection, moorings, and public landings. Santa Catalina Island is within one-day range of the mainland coast from Dana Point to Point Dume. In order to accommodate the tremendous numbers of transient vessels from the mainland, it is proposed that high-density moorings be installed in some coves and bays.

The estimated needs for transient overnight facilities would total about 20,000 units by 2020. (See Table SC-8). The transient capacity of Santa Catalina Island, without irreparably damaging the quality of the recreation it affords, is estimated at 8,000 units. The existing and proposed mainland harbors could accommodate part of the remaining demand through interchange of boats between harbors; however, with some exceptions, notably Mission Bay and Newport Bay, existing coastal harbors do not afford unusually attractive destinations. Transient use of existing and proposed coastal harbors by the year 2020 is estimated at about 4,000 boats on a peak-weekend. The possibility of developing additional destinations on the mainland coast, with fair-weather protection, at attractive sites not proposed for harbor development was investigated. If transient moorings can be incorporated within proposals for developing beach parks, four or five sites appear feasible. The most favorable sites appear to be La Jolla, Laguna, Malibu Creek, Topanga Creek, and Sequit Point. The balance of the un-met demand could be met within the Central Coastal subregion and by development of transient facilities in Baja California. Plans under study by the Mexican Government propose construction of coastal harbors in Baja California within cruising range of southern California. It is estimated that these harbors could provide about 2,000 transient moorings each time frame, starting in 1980, for a total of 6,000 moorings during the study period. If these facilities in Mexican waters do not materialize, transient mooring needs would be unmet to that extent.

Implementation

Construction of navigation facilities in the South Coastal subregion would require dredging of about 480 million cubic yards of material between the years 1966 and 2020 and construction of about 15 miles of protective breakwaters and jetties. About 270 million cubic yards of this dredging would be required for commercial navigation facilities, including about 100 million yards of dredging for borrow material with which to construct moles. Estimated construction quantities, not including revetment or bulkheads, are as follows:

Commercial Navigation

Item	Unit	1966-1980	1981-2000	2001-2020
Dredging navigation features	Cu.yds.	43,600,000	58,400,000	24,000,000
Other dredging and borrow	Cu.yds.	80,000,000	40,000,000	24,000,000
Breakwaters and jetties	Lin.ft.	0	0	8,000

Recreational Navigation

Item	Unit	1966-1980	1981-2000	2001-2020
Dredging navigation features	Cu.yds.	600,000	1,600,000	4,000,000
Other dredging and borrow	Cu.yds.	10,200,000	51,200,000	145,000,000
Breakwaters and jetties: Proposed, Federal	Lin.ft.	12,000	18,000	34,000
Proposed, non-Federal	Lin.ft.	2,000	6,000	10,000

Maintenance would consist of maintenance dredging of navigation features and other water areas, and maintenance of protective structures. Quantities of dredging required to maintain existing and potential navigation features are as follows:

	Total cubic yards (thousands)			
	1965	1980	2000	2020
Federal	500	950	1,450	2,100
Non-Federal	50	150	400	600
Total	550	1,100	1,850	2,700

Annual sand-bypassing of harbor entrances, where the primary purpose is shore protection or beach nourishment, is not included. (See Appendix XVI: Shoreline Protection and Development).

Order-of magnitude estimates of first costs and operation and maintenance for required navigation improvements were based upon historical cost trends, costs for typical existing facilities, average unit costs for dredging and breakwater construction, and existing preliminary cost estimates adjusted to 1965 price levels. Bases for cost estimates and for cost allocations are set forth in the Regional Summary. Estimated future costs would be as follows:

Summary of first Costs

Feature	1966-1980	1981-2000	2001-2020
	(millions)	(millions)	(millions)
Commercial navigation:			
Federal	$ 17.4	$ 20.0	$ 22.0
Non-Federal	194.0	226.0	250.0
Recreational navigation:			
Federal	11.0	40.0	47.0
Non-Federal	53.2	130.0	153.0

Summary of annual maintenance costs

Feature	1980	2000	2020
	(millions)	(millions)	(millions)
Commercial navigation:			
Federal	$ 0.9	$ 2.0	$ 2.3
Non-Federal	0.5	0.8	0.8
Recreational navigation:			
Federal	1.9	4.0	4.6
Non-Federal	2.0	3.0	3.2

SOUTH COASTAL SUBREGION

TABLE SC-1

Summary of Waterborne Commerce,[1] 1965 - 2020

Type of Commerce	1965[2]	1980	2000	2020
Foreign exports				
San Diego Harbor	518	2,330	2,910	4,300
Los Angeles-Long Beach harbors	7,111	15,060	21,430	31,280
Port Hueneme Harbor	37	180	190	200
All other	247	400	550	700
Total, exports	7,913	17,970	25,080	36,480
Foreign imports				
San Diego Harbor	421	530	1,060	2,160
Los Angeles-Long Beach harbors	12,085	16,900	27,960	41,550
Port Hueneme Harbor	0	90	120	160
All other	1,043	1,850	2,500	3,000
Total, imports	13,549	19,370	31,640	46,870
Coastwise shipments				
San Diego Harbor	17	50	100	210
Los Angeles-Long Beach harbors	7,935	8,790	9,410	12,730
Port Hueneme Harbor	1	10	10	10
All other	2,478	5,570	10,000	10,500
Total, shipments	10,431	14,420	19,520	23,450
Coastwise receipts				
San Diego Harbor	553	670	760	890
Los Angeles-Long Beach harbors	5,686	6,790	8,860	12,120
Port Hueneme Harbor	65	430	470	300
All other	2,105	3,700	5,200	6,500
Total, receipts	8,409	11,590	15,290	19,810
Total Commerce[3]				
San Diego Harbor	1,509	3,580	4,830	7,560
Los Angeles-Long Beach harbors	32,817	47,540	67,660	97,680
Port Hueneme Harbor	103	710	790	670
All other	5,873	11,520	18,250	20,700
Grand total, subregion	40,302	63,350	91,530	126,610

1/ Thousands of short tons

2/ From Waterborne Commerce of the United States, Part 4, Department of the Army, Corps of Engineers

3/ Local and internal traffic is not significant in this subregion

SOUTH COASTAL SUBREGION

TABLE SC-2

Los Angeles and Long Beach Harbors,

1965 Waterborne Commerce[1/], and Projected Waterborne Commerce
1980-2020

Commodity group	1965[2/]	1980	2000	2020
Foreign exports				
Iron and steel scrap	477	920	1,550	2,490
Iron ore	1,596	3,530	3,530	3,530
Fertilizers	455	920	1,500	2,050
Chemicals and nonmetallic minerals	609	1,090	1,750	2,400
Coal	0	1,220	2,150	5,000
Miscellaneous industrial products	828	2,310	2,940	3,850
Agricultural products	1,310	3,170	5,260	7,460
Petroleum products	1,836	1,900	2,750	4,500
Total foreign exports	7,111	15,060	21,430	31,280
Foreign imports				
Iron and steel products	1,059	1,580	2,770	3,900
Non-metallic minerals	454	700	1,040	1,370
Pulp and paper	442	880	1,580	2,480
Miscellaneous industrial products	717	1,170	1,850	2,670
Agricultural products	945	1,490	2,220	3,000
Crude petroleum	6,466	8,420	14,060	21,380
Petroleum products	2,002	2,660	4,440	6,750
Total foreign imports	12,085	16,900	27,960	41,550
Coastwise shipments				
Vehicles and parts	36	50	80	130
Chemical products	224	390	580	830
Miscellaneous industrial products	196	200	290	430
Agricultural products	125	150	240	350
Crude petroleum	290	400	410	550
Petroleum products	7,064	7,600	7,810	10,440
Total coastwise shipments	7,935	8,790	9,410	12,730
Coastwise receipts				
Chemical products	249	460	690	1,000
Lumber and wood products	899	1,280	2,040	3,180
Iron and steel products	236	390	580	840
Miscellaneous industrial products	244	250	300	370
Agricultural products	168	240	360	520
Crude petroleum	1,742	1,920	2,350	3,100
Petroleum products	2,148	2,250	2,540	3,110
Total coastwise shipments	5,686	6,790	8,860	12,120

See foot notes at end of table.

Continued

SOUTH COASTAL SUBREGION

TABLE SC-2

Los Angeles and Long Beach Harbors,

1965 Waterborne Commerce[1/], and Projected Waterborne Commerce 1980-2020 (Cont.)

Commodity group	1965[2/]	1980	2000	2020
Total commerce[3/] Los Angeles and Long Beach harbors	32,817	47,540	67,660	97,680

1/ Thousands of short tons
2/ From Waterborne Commerce of the United States, Part 4, Department of the Army, Corps of Engineers
3/ Local and internal traffic is not significant at this port.

SOUTH COASTAL SUBREGION

TABLE SC-3

San Diego Harbor

1965 Waterborne Commerce[1/], and Projected Waterborne Commerce 1980-2020

Commodity group	1965[2/]	1980	2000	2020
Foreign exports				
Farm products	71	180	390	1,000
Potash	253	380	600	1,090
Iron ore pellets	0	1,500	1,500	1,500
Scrap steel	99	120	170	290
Miscellaneous	95	150	250	420
Total, foreign exports	518	2,330	2,910	4,300
Foreign imports				
Cane molasses	18	100	150	220
Petroleum products	268	0	0	0
Plywood	36	130	210	310
Newsprint	33	70	160	380
Miscellaneous	66	230	540	1,250
Total, foreign imports	421	530	1,060	2,160
Coastwise shipments				
Beet molasses	0	30	50	80
Miscellaneous	17	20	50	130
Total, coastwise shipments	17	50	100	210
Coastwise receipts				
Petroleum products	371	450	460	500
Lumber	172	210	290	380
Miscellaneous	10	10	10	10
Total, coastwise receipts	553	670	760	890
Total commerce [3/] San Diego Harbor	1,509	3,580	4,830	7,560

1/ Thousands of short tons

2/ From Waterborne Commerce of the United States, Part 4, Department of the Army, Corps of Engineers.

3/ Local and internal traffic is not significant at this port.

SOUTH COASTAL SUBREGION

TABLE SC-4

Port Hueneme Harbor,

1965 Waterborne Commerce[1/], and Projected Waterborne Commerce
1980-2020

Commodity group	1965[2/]	1980	2000	2020
Foreign exports				
Fertilizer	6	30	30	30
Chemical products	0	25	25	25
Diatomaceous earth	28	70	70	70
Cotton	0	50	55	60
Miscellaneous	3	5	10	15
Total, foreign exports	37	180	190	200
Foreign imports				
Raw chemicals	0	70	70	70
Miscellaneous	0	20	50	90
Total, foreign imports	0	90	120	160
Coastwise shipments				
Miscellaneous	1	10	10	10
Total, coastwise shipments	1	10	10	10
Coastwise receipts				
Lumber	60	410	440	270
Miscellaneous	5	20	30	30
Total, coastwise receipts	65	430	470	300
Total commerce[3/], Port Hueneme Harbor	103	710	790	670

1/ Thousands of short tons.
2/ From Waterborne Commerce of the United States, Part 4, Department of the Army, Corps of Engineers.
3/ Local and internal traffic is not significant at this port.

SOUTH COASTAL SUBREGION

TABLE SC-5

Existing and Projected Commercial Navigation Features and Terminal Facilities

	1965	1980	2000	2020
LOS ANGELES - LONG BEACH HARBORS				
Navigation features, outer harbors:				
Breakwaters, miles	8.2	8.0	8.0	8.0
Approach channel:				
Depth, feet	--	70	82	82
Length, miles	0	1.0	1.5	1.5
Entrance channel:				
Depth, feet	50±	68	80	80
Length, miles	3.5	4.7	4.7	4.7
Navigation channel:				
Depth, feet	35	65	75	75
Length, miles	1.0	2.6	4.0	4.0
Turning basins:				
Depth, feet	50±	65	75	75
Area, acres	6	35	35	35
Anchorage areas:				
Depth, feet	50±	65	75	75
Area, acres	43	20	20	20
Navigation features, inner harbors:				
Navigation channel:				
Depth, feet	35	42	42	42
Length, miles	7.3	7.3	7.3	7.3
Turning basins:				
Depth, feet	35	42	42	42
Area, acres	25	25	25	25
Terminal facilities:				
Berths, number	80[1/]	75	87	108
Cargo-handling area, acres	1,400	1,600	2,100	3,400

1/ Not including inadequate or substandard facilities, or facilities not used for waterborne commerce (excluding fish).

SOUTH COASTAL SUBREGION

TABLE SC-5

Existing and Projected Commercial Navigation Features and Terminal Facilities. (Cont.)

	1965	1980	2000	2020
SAN DIEGO HARBOR				
Navigation features:				
Jetty, miles	1.4	1.4	1.4	1.4
Entrance channel:				
Depth, feet	41	42	42	46
Length, miles	2.4	2.4	2.4	2.4
North channel:				
Depth, feet	39	42	42	44
Length, miles	4.6	4.6	4.6	4.6
Central channel:				
Depth, feet	29	40	40	40
Length, miles	1.8	1.8	1.8	1.8
South channel:				
Depth, feet	29	35	35	40
Length, miles	3.2	4.7	4.7	6.2
Turning basins:				
Depth, feet	35	40	40	42
Area, acres	30	35	35	40
Anchorage area:				
Depth, feet	26	35	35	40
Area, acres	330	330	330	330
Terminal facilities:				
Berths, number	16	17	19	26
Cargo-handling area, acres	27	245	275	375

SOUTH COASTAL SUBREGION

TABLE SC-5

Existing and Projected Commercial Navigation Features and Terminal Facilities. (Cont.)

	1965	1980	2000	2020
PORT HUENEME HARBOR				
Navigation features:				
Jetties:				
Length, miles	0.34	0.34	0.34	0.34
Approach channel:				
Depth, feet	40	40	40	40
Length, miles	0.15	0.15	0.15	0.15
Entrance channel:				
Depth, feet	36	36	36	36
Length, miles	0.29	0.29	0.29	0.29
Navigation channel:				
Depth, feet	32	35	35	35
Length, miles	0.35	0.54	0.54	0.54
Turning basins:				
Depth, feet	32	35	35	35
Area, acres	25.4	25.4	25.4	25.4
Anchorage area:				
Depth, feet	--	--	--	--
Area, acres	0	0	0	0
Terminal facilities:				
Berths, numbers	3	5	5	5
Cargo-handling area, acres	15	50	50	50

SOUTH COASTAL SUBREGION

TABLE SC-5

Existing and Projected Commercial Navigation and Terminal Facilities. (Cont.)

	1965	1980	2000	2020
OFFSHORE PETROLEUM TERMINALS				
Navigation features:				
Depth feet:				
Encina	40	42	42	42
Huntington Beach	50	70	82	82
El Segundo	58	70	82	82
Ventura	42	42	42	42
Terminal facilities:				
Berths, number	4	4	4	4

SOUTH COASTAL SUBREGION

TABLE SC-6

Recreational Navigation Needs, 1965-2020

	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	2.4 1/	3.4	4.7	5.0
Subregion population, thousands	10,000	13,900	19,200	23,800
Number of berths needed	24,000	47,000	90,000	119,000
Trailered boats				
Number of trailered boats using navigable waters	30,000	60,000	130,000	230,000
Number of peak-day launchings	6,500	13,500	28,000	51,000
Launching facilities needed 2/	130	270	560	1,020
Transient boats				
Number of peak-weekend overnight transient boats	3,200	6,000	12,000	20,000

1/ Under existing conditions (1965) actual ratio is 1.7, reflecting constraint of insufficient berthing facilities on berthed boat ownership.

2/ Launching lanes 12 feet wide or hoists with launching capacity of 50 boats per peak day.

SOUTH COASTAL SUBREGION

TABLE SC-7

Berthing Capacity of Existing, Programmed and Projected Recreational Navigation Facilities, 1965-2020

	Berthing Capacity			
	1965	1980	2000	2020
1. EXISTING FACILITIES (1965)				
Federal projects: 1/				
Mission Bay Harbor	1,060	2,000	3,000	4,000
Oceanside Harbor	525	525	525	525
Newport Bay Harbor	4,275	4,500	4,500	4,500
King Harbor Redondo	1,020	1,400	1,400	1,400
Marina del Rey	1,800	6,000	6,000	6,000
Channel Islands Harbor	200	1,950	1,950	1,950
Subtotal, Federal	8,880	16,375	17,375	18,375
Non-Federal improvements:				
Shelter Island San Diego	1,350	1,500	1,500	1,500
Long Beach Marina	1,800	1,800	1,800	1,800
Ventura Marina	350	0	0	0
Subtotal, non-Federal	3,500	3,300	3,300	3,300
Private improvements:				
San Diego Bay area	150	300	500	500
Huntington Harbor	800	1,750	1,750	1,750
Alamitos Bay area	850	900	900	900
Los Angeles-Long Beach Harbors area	3,420	1,500	1,000	0
Subtotal, private	5,220	4,450	4,150	3,150
TOTAL, EXISTING FACILITIES	17,600	24,125	24,825	24,825
2. FACILITIES PROGRAMMED FOR CONSTRUCTION (1965) 2/				
Federal projects:				
Dana Point Harbor		1,300	2,150	2,150
Ventura Marina modification		1,300	2,000	2,500
Subtotal, non-Federal		2,600	4,150	4,650
Non-Federal improvements:				
Harbor Island San Diego		1,000	1,000	1,000
Sunset Bay		250	500	1,000
Avalon Harbor 3/		25	25	25
Subtotal, non-Federal		1,275	1,525	2,025
Private improvements				
None		0	0	0
TOTAL, PROGRAMMED FOR CONSTRUCTION		3,875	5,675	6,675
GRAND TOTAL, EXISTING AND PROGRAMMED FACILITIES	17,600	28,000	30,500	31,500

See footnotes at end of table.

Continued.

SOUTH COASTAL SUBREGION

TABLE SC-7

Berthing Capacity of Existing, Programmed and Projected Recreational Navigation Facilities, 1965-2020 (Cont.)

	Berthing Capacity			
	1965	1980	2000	2020
3. PROJECTED FACILITIES NOT PROGRAMMED				
Federal projects				
San Diego County		500	1,000	2,000
Orange County		1,000	6,000	7,000
Los Angeles County		500	2,000	5,000
Ventura County		0	1,000	1,000
Subtotal, Federal		2,000	10,000	15,000
Non-Federal improvements				
San Diego County		1,000	3,000	6,000
Orange County		1,000	4,500	10,500
Los Angeles County		1,000	8,000	17,000
Ventura County		0	0	0
Subtotal, non-Federal		3,000	15,500	33,500
TOTAL PROJECTED FACILITIES NOT PROGRAMMED		5,000	25,500	48,500
GRAND TOTAL	17,600	33,000	56,000	80,000

1/ Including Federal maintenance projects.
2/ Authorized Federal projects, and non-Federal public and private improvements under construction.
3/ Primarily a destination harbor.

SOUTH COASTAL SUBREGION

TABLE SC-8

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	24,000	23,000	47,000	43,000	90,000	29,000	119,000
Needs met:							
Within facilities existing in 1965 1/	17,600	6,525	24,125	700	24,825	0	24,825
Within facilities definitely programmed in 1965	0	3,875	3,875	1,800	5,675	1,000	6,675
Within projected facilities not programmed in 1965	0	5,000	5,000	20,500	25,500	23,000	48,500
Through dry storage in lieu of berthing	0	14,000	14,000	20,000	34,000	5,000	39,000
Incremental additions		29,400		43,000		29,000	
TOTAL	17,600		47,000		90,000		119,000
Residual un-met needs	6,400		0		0		0
Launching lanes							
Needs	130	140	270	290	560	460	1,020
Needs met:							
By lanes existing in 1965	200	0	200	0	200	0	200
By projected lanes	0	70	70	290	360	460	820
Incremental additions		70		290		460	
TOTAL	200		270		560		1,020
Residual un-met needs	0		0		0		0

See footnotes at end of table.

Continued.....

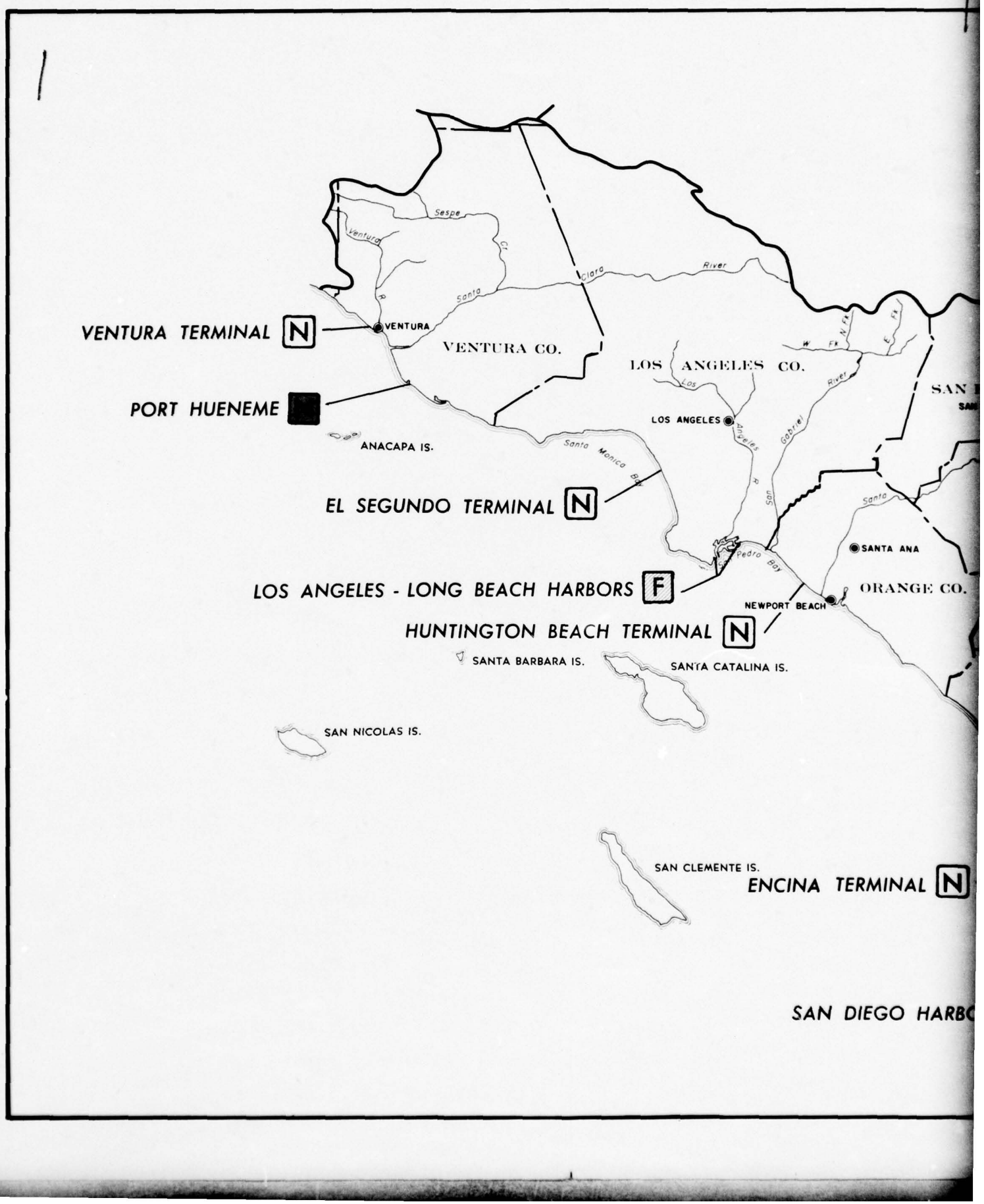
SOUTH COASTAL SUBREGION

TABLE SC-8

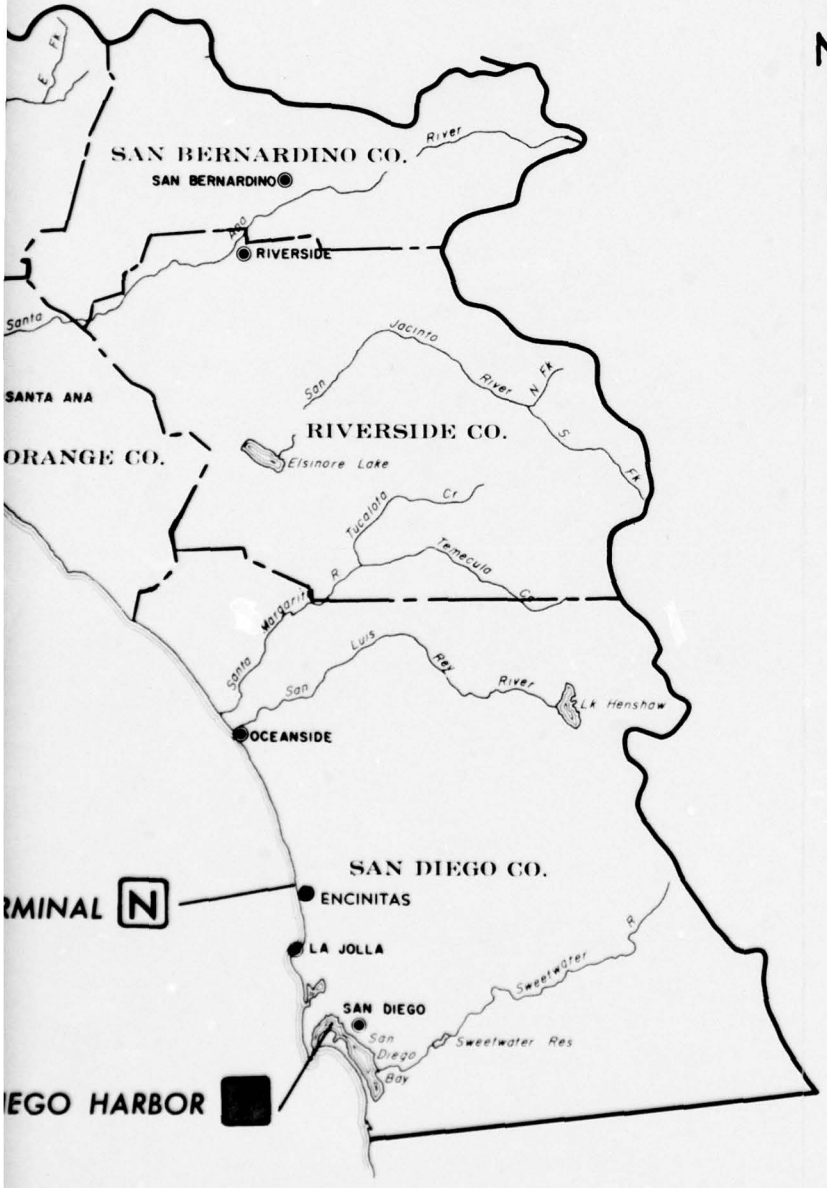
Summary of Plan to Meet Needs for Recreational Navigation (Cont.)

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Transient moorings							
Needs	3,200	2,800	6,000	6,000	12,000	8,000	20,000
Needs met							
By moorings existing in 1965	2,000	0	2,000	0	2,000	0	2,000
By projected moorings in subregion	0	2,000	2,000	4,000	6,000	6,000	12,000
By projected moorings in Baja California, Mexico	0	2,000	2,000	2,000	4,000	2,000	6,000
Incremental additions		4,000		6,000		8,000	
TOTAL, needs met	2,000		6,000		12,000		20,000
Residual un-met needs	1,200		0		0		0

1/ To be developed through self-liquidating improvements not included in cost estimates in this appendix.


VENTURA TERMINAL N
PORT HUENEME
EL SEGUNDO TERMINAL N
LOS ANGELES - LONG BEACH HARBORS F
HUNTINGTON BEACH TERMINAL N
ENCINA TERMINAL N
SAN DIEGO HARBO
VENTURA
VENTURA CO.
LOS ANGELES CO.
LOS ANGELES
SANTA ANA
ORANGE CO.
NEWPORT BEACH
ANACAPA IS.
SANTA BARBARA IS.
SANTA CATALINA IS.
SAN NICOLAS IS.
SAN CLEMENTE IS.
Sespe
Ventura
Santa
Clara
River
Los
Angeles
San
Gabriel
Santa Monica Bay
Pedro Bay
Santa

2



N

RMINAL [N]

IEGO HARBOR

LEGE

EXISTING DEVELOPMENT

[F] Existing Federal pro

[N] Existing non-Federal and oil terminal

POTENTIAL DEVELOPMENT

Existing harbor pro

Existing harbor requ programmed

SOUTH C
CALI

COMMERC
DEV

10

LEGEND

EXISTING DEVELOPMENT (1965)

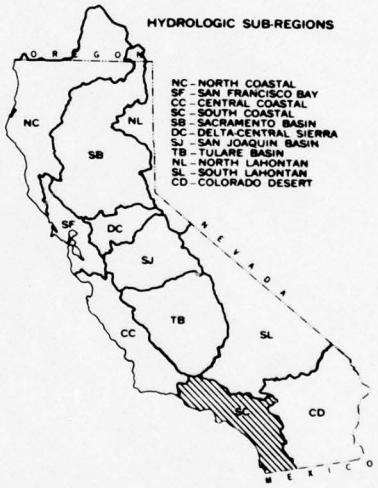
[F] Existing Federal project harbor

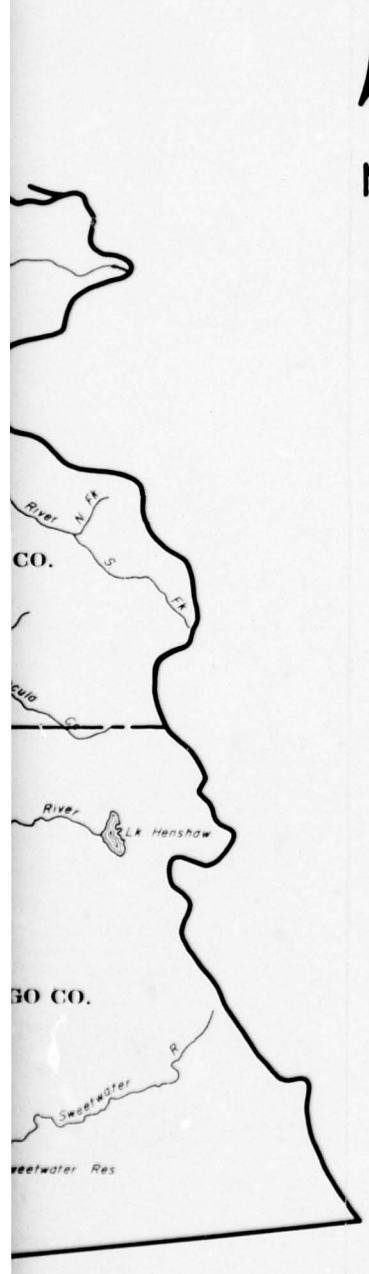
[N] Existing non-Federal project harbor and oil terminal

POTENTIAL DEVELOPMENT

Existing harbor programmed for expansion

Existing harbor requiring expansion, not programmed





MAP SC-1

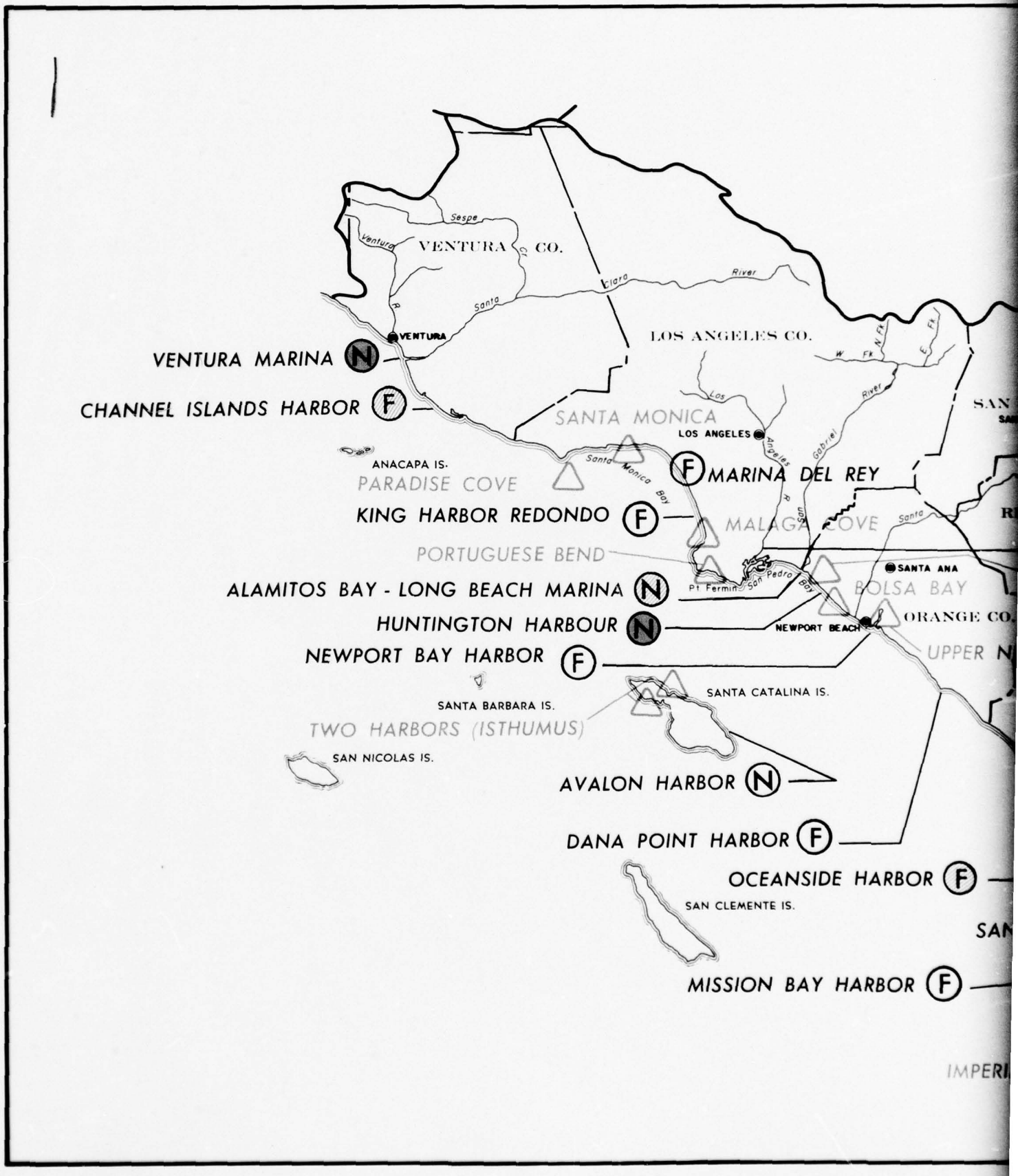
SOUTH COASTAL SUBREGION

CALIFORNIA REGION

COMMERCIAL NAVIGATION DEVELOPMENT

10 0 10 20

SCALE IN MILES


VENTURA MARINA (N)
CHANNEL ISLANDS HARBOR (F)
KING HARBOR REDONDO (F)
ALAMITOS BAY - LONG BEACH MARINA (N)
HUNTINGTON HARBOUR (N)
NEWPORT BAY HARBOR (F)
AVALON HARBOR (N)
DANA POINT HARBOR (F)
OCEANSIDE HARBOR (F)
MISSION BAY HARBOR (F)
(F) MARINA DEL REY
VENTURA
LOS ANGELES
SANTA ANA
NEWPORT BEACH
VENTURA CO.
LOS ANGELES CO.
ORANGE CO.
SANTA MONICA
MALAGA COVE
BOLSA BAY
PARADISE COVE
PORTUGUESE BEND
ANACAPA IS.
SANTA BARBARA IS.
SANTA CATALINA IS.
SAN NICOLAS IS.
SAN CLEMENTE IS.
TWO HARBORS (ISTHUMUS)
Pt. Fermin
Santa Monica Bay
San Pedro Bay
Sespe
Ventura
Santa Clara River
Los Angeles River
San Gabriel
W. Fk.
N. Fk.
E. Fk.

1

2

LEGEND

EXISTING DEVELOPMENT (1965)

(F) Existing Federal project harbor

(N) Existing non-Federal harbor or marina

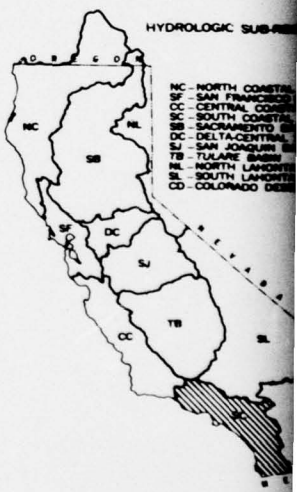
POTENTIAL DEVELOPMENT

Existing harbor or marina programmed for expa

Existing harbor or marina requiring expansion, no

Possible site for harbor or marina to meet future

(N) LOS ANGELES - LONG BEACH HARBOR MARINAS



SOUTH COA
CALIFO
RECREATIONA
DEVE
SCA

LEGEND

EXISTING DEVELOPMENT (1965)

(F) Existing Federal project harbor

(N) Existing non-Federal harbor or marina

POTENTIAL DEVELOPMENT

Existing harbor or marina programmed for expansion

Existing harbor or marina requiring expansion, not programmed

Possible site for harbor or marina to meet future requirements

(N) LOS ANGELES - LONG BEACH HARBOR MARINAS

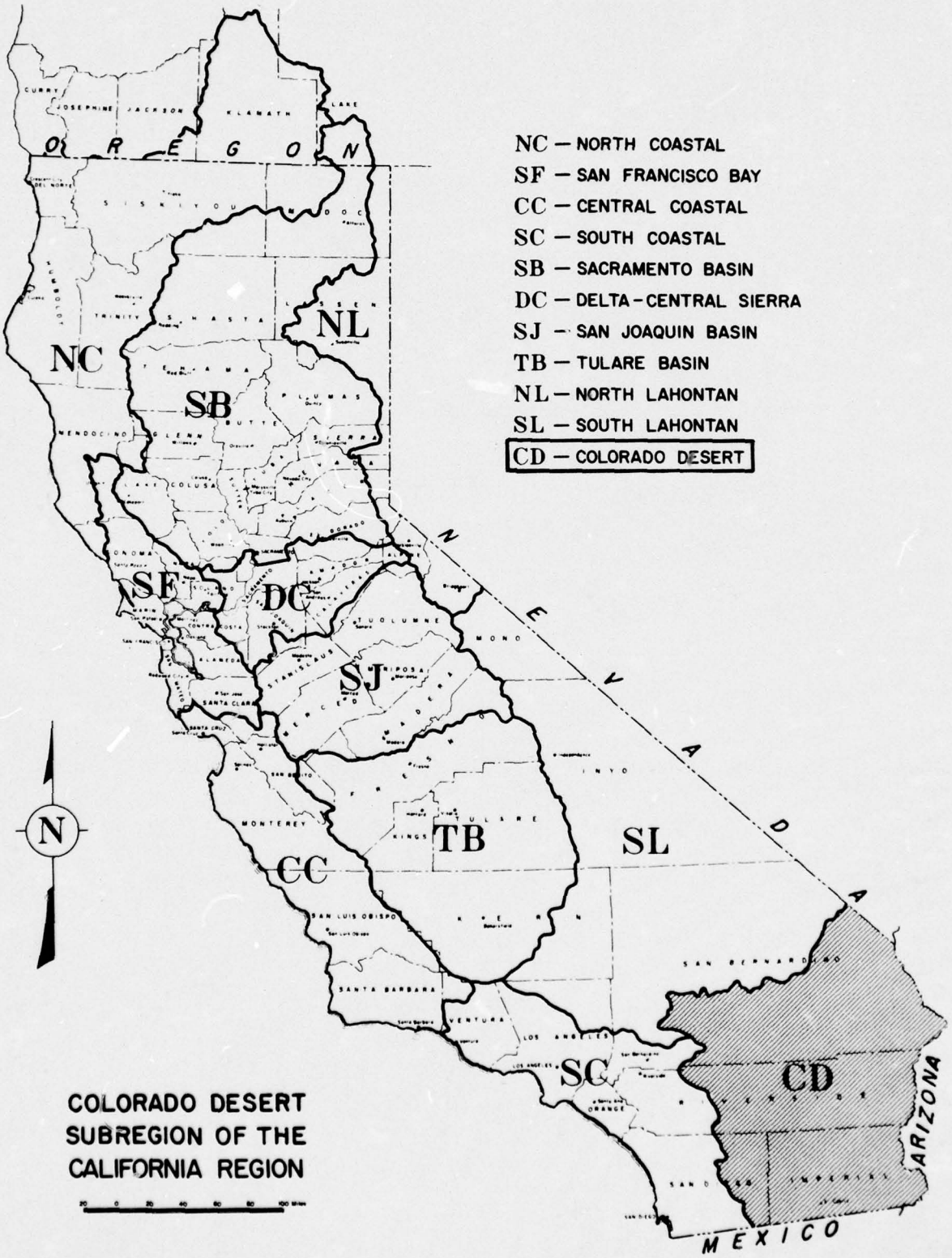
MAP SC-2

SOUTH COASTAL SUBREGION
CALIFORNIA REGION

RECREATIONAL NAVIGATION DEVELOPMENT

10 0 10 20
SCALE IN MILES

COLORADO DESERT SUBREGION



COLORADO DESERT SUBREGION OF THE CALIFORNIA REGION

COLORADO DESERT SUBREGION

General

The Colorado Desert subregion occupies the extreme southeastern part of the Region, and extends from the California-Mexico boundary north to the South Lahontan subregion boundary; and from the Colorado River to the San Bernardino and San Jacinto Mountains and the divide of the coast range in the eastern part of San Diego County. The subregion is described in detail in Appendix II.

The Colorado Desert subregion has only one body of water that is a navigable water of the United States -- the lower Colorado River. The Salton Sea, which is also located in the subregion, is classed as an inland water.

Classification of the lower Colorado River as a navigable water of the United States is based, in part, on its historical use for commercial navigation. Navigation of the lower Colorado River commenced in the early 1850's and was initiated to supply Fort Yuma. The right to navigate the Gulf of California and the Colorado River from the Gulf to United States territory was assured by a treaty with Mexico dated December 30, 1853.

Commercial navigation on the lower Colorado River was of importance for only about three decades, but contributed greatly to the development of the Arizona Territory. At the peak of commercial operations, cargo shipped by oceangoing steamship from San Francisco and transshipped to river steamers and barges at the mouth of the river was delivered to Fort Yuma in 12 days. Regular schedules were maintained for river traffic from the mouth of the river to Fort Yuma and as far upriver as Hardyville, 312 river-miles above Yuma. Non-scheduled traffic was occasionally carried as far upriver as the Virgin River confluence. Steamboat service between Yuma and the Gulf of California was discontinued shortly after the railroad reached Yuma in 1877. The upriver service between Yuma and El Dorado was continued until the completion of Laguna Dam in 1909.

After years of negotiation, the Colorado River Compact was approved in 1922 and became the "law of the river" by Presidential Proclamation on June 25, 1929. Article IV of the Compact states in part:

> "(a) Inasmuch as the Colorado River has ceased to be navigable for commerce and the reservation of its waters for navigation would seriously limit the development of its basin, the use of its waters for purposes of navigation shall be subservient to the uses of such waters for domestic, agricultural, and power purposes. * * *"

The construction of the great conservation works on the river by the Bureau of Reclamation started with Hoover Dam in 1934. For the next 15 years, increasing numbers of sportsmen were attracted to the river, drawn by the fine fishing in the impoundments and in the clear water downstream from the dams. Beginning about 1950, recreational boating on the Colorado River was stimulated by the development of trailered boats, interest in water skiing, increased leisure and income of the rapidly expanding population, and improved highway access to the river from southern California.

About 90 percent of the use of the lower Colorado River for recreational navigation in 1965 was by the 9.9 million residents of the South Coastal subregion of California. The remaining 10 percent use was mostly derived from the Colorado Desert subregion of California and from Arizona. Total boating use in 1965 was estimated by the U.S. Coast Guard at about 192,000 boat-days annually. The annual use by boats originating in the South Coastal subregion is estimated at 175,000 boat days. Use of the lower Colorado River by California boats, which is almost exclusively by trailered boats, is concentrated on weekends, particularly holiday weekends, and on summer vacations.

Certain regulatory problems along the lower Colorado River are pertinent to recreational boating on the river and warrant brief discussion. Illegal occupancy of public lands withdrawn under the Reclamation Act of 1902, and of lands subsequently acquired by the Bureau of Reclamation, has been occurring along the lower Colorado River since construction of Laguna Dam in 1909. By 1961, about 800 cases of illegal occupancy were involved. The Secretary of the Interior moved to solve this problem by setting up the Lower Colorado Land Use Office, in May of 1961, to effect control of illegal occupancy by a permit system. Coincident with this program, the Corps of Engineers moved to effect removal of obstacles to navigation and sources of pollution of the navigable waters of the river. An effort was made to acquaint both the private and public sectors with the laws enacted for the preservation and protection of navigable waters.

These laws are administered through a permit system. Since 1961, permits have been granted for both existing and proposed structures along the river at the rate of about 60 permits a year. Removal of a number of illegal structures and sources of pollution, for which permits could not be granted, has been effected. Aside from control of structures and pollution in the navigable waters, other interferences with recreational boating are created by the numerous natural snags in Lake Havasu and the presence of floating debris in the river, derived from miscellaneous material placed along the banks to protect them from erosion. A program to effect removal of these types of impairments to small-craft navigation is being pursued.

Existing Development

The reach of the lower Colorado River contiguous with the Colorado Desert subregion is approximately 265 miles long. About 213 miles are river channel, about 42 miles are the impoundment behind Parker Dam (Lake Havasu), and about 10 miles are the impoundment behind Imperial Dam. The river has been channelized by the Bureau of Reclamation from Davis Dam (in the Lower Colorado Region) to below Needles.

Boating facilities are located on both the Arizona side and the California side of the river. The 17-mile strip from the city of Parker, Arizona to Parker Dam and Lake Havasu accounts for almost 60 percent of the total berthing facilities and almost 50 percent of the total launching facilities. The remaining berthing and launching facilities are about evenly distributed between the Needles area, the Blythe area, and the Yuma area. The location of major boating areas is shown on Map CD-1.

Boating facilities on the lower Colorado River are mostly trailered-boat facilities of one sort or another. Although there were about 1,300 usable berths, about two-thirds of these berths were occupied on a seasonal basis for wet storage of trailered boats. Dry-storage facilities for trailered boats ranged from enclosed storage space to open parking areas. It is estimated that there were about 1,400 developed dry-storage spaces in 1965 and launching ramps and hoists providing the equivalent of about 140 lanes.

An appraisal of the adequacy of boating facilities on the Lower Colorado River is difficult because of the variety and number of developments river and the lack of records of visitor use. The Lower Colorado River Land Use Advisory committee, in a report dated January 1964, titled "The Lower Colorado River Land Use Plan," stated that peak-weekend use overflowed onto every available piece of land along the river. The report indicated that visitor use has doubled in less than 10 years and is likely to continue to increase rapidly. It is estimated that overuse of launching facilities is to the extent of about 15 percent.

A field examination of boating facilities on the river was made in January 1968. At that time, the Needles, Blythe, and Yuma areas were all adversely affected by the low water level in the river. Interviews with numerous facility operators were conducted, and the consensus was that inadequate water for recreational boating, except in impoundments, was the major problem on the river. In the Blythe area, many of the berthing facilities had been damaged by low water, and some of the marinas no longer had access to navigable channels. Unfortunately, the lowest stage of the river appears to coincide with the peak recreational boating season.

Future Needs

GENERAL

Present projections indicate that future needs for navigation would consist entirely of recreational navigation facilities. The possibility of developing a deep-draft harbor facility at Yuma connecting to the Gulf of California has been discussed for the past decade or so. At the present time, no significant need for this facility can be demonstrated. However, should future projections indicate that substantial quantities of bulk commodities would be generated in the Upper and Lower Colorado Desert Regions, further consideration should be given to the need for commercial navigation facilities.

RECREATIONAL NAVIGATION

General

Recreational navigation facilities were assessed in terms of berthing facilities and launching facilities. Because of the nature of the boating waters, construction of transient and destination facilities would not be required. Cruising boats can tie to the river banks in backwaters and embayments along shore. Needs for recreational navigation are discussed in the following paragraphs and are summarized in Table CD-1.

Berthing Facilities

Present and projected needs for berthing facilities were based upon projected berthable boats generated by the Colorado Desert subregion. Consideration was given to the positive effects of increased disposable income, which will tend to encourage ownership of larger boats. The ratio of berthable boats to population was estimated at 2.0 berthable boats per thousand in 1965, 3.0 in 1980, 4.0 in 2000, and 5.0 in 2020. The need for berths is estimated at 425 in 1965, 1,000 in 1980, 2,200 in the year 2000, and 4,500 in 2020. These berthing needs do not include berths for optional wet storage of trailerable boats. Although a surplus of berthing facilities apparently exists on the river at present, two-thirds of the berths are occupied as optional wet storage by trailered boats. No attempt has been made to project the future requirements for optional berthing for trailered boats.

Trailered-boat Facilities

Trailered-boat facilities comprise launching ramps, dry-storage facilities and supporting picnic and camping facilities. On the lower Colorado River, there is a substantial need for dry-storage facilities for boats owned by residents of the South Coastal subregion who do not wish to trailer their boats over such a great distance. Because much of the recreational use of the river is generated by residents of the South Coastal subregion,

and this recreational use is generally weekend use, camping areas are of considerable importance. The requirements for dry storage and camping facilities are included in general estimates of recreational needs in Appendix XII: Recreation. It is expected that the majority of the trailered boats using the river will continue to come from the South Coastal subregion. An estimated 30,000 trailered boats were using the river in 1965, and, as previously stated, over 90 percent of these boats were from the South Coastal subregion. It is estimated that use of the river by trailered boats will increase tenfold by the year 2020, requiring a tremendous increase in the number of launching facilities. Launching lanes needed for 1965, 1980, 2000, and 2020, in equivalent 12-foot lanes, are estimated to be 160, 340, 900, and 1,700, respectively.

Means to Satisfy Future Needs

Facilities required to satisfy recreational-navigation needs are summarized in Table CD-2. The future berthing needs for berthable boats can be satisfied by construction of berths at Lake Havasu and the 17-mile strip. These bodies of water, at present, afford the only assured depth adequate for berthable boats. No substantial protective works would be required in these sheltered waters: however, basins with bank protection would be needed. The future needs for trailered boats can be met through construction of more launch ramps. The plan to meet needs for recreational navigation is summarized in Table CD-2.

Improved access to the river would be necessary; many reaches that are greatly under-utilized at present, because of poor access, possess outstanding recreational potential. Full recreational use of the river would be greatly enhanced by maintenance of a minimum water level compatible with recreational boating needs. Channelization, which would achieve this minimum level by dredging or bank revetment, is anticipated by the Bureau of Reclamation for most of the river below Headgate Dam. In the course of such work, however, the impact upon scenic values and upon fish and wildlife resources will require careful consideration.

Implementation

Implementation of the navigation plan for the Colorado Desert subregion would require construction of berthing basins and launching ramps. It is estimated that the cost of providing boating facilities would be about $10,000 per launching lane, exclusive of support facilities, and about $2,000 per berth for basin construction, revetment, utilities and other non-revenue producing features. It is probable that these facilities would be constructed and maintained by local and private interests. First costs and average annual maintenance costs are estimated as follows:

First Costs

Feature	1966-1980 (millions)	1981-2000 (millions)	2001-2020 (millions)
Commercial navigation facilities	0	0	0
Recreational navigation facilities:			
Federal	0	0	0
Non-Federal	$2.4	$6.3	$12.2

Average Annual Maintenance

Feature	1980 (millions)	2000 (millions)	2020 (millions)
Federal	0	0	0
Non-Federal	$0.1	$0.3	$0.6

COLORADO DESERT SUBREGION

TABLE CD-1

Recreational Navigation Needs, 1965 - 2020

	1965	1980	2000	2020
Berthable boats				
Ratio, berthable boats per thousand population	2.0	3.0	4.0	5.0
Subregion population, thousands	213	330	560	1,132
Number of berths needed	425	1,000	2,200	4,500
Trailered boats				
Number of trailered boats using navigable waters	30,000	60,000	160,000	300,000
Number of peak-day launchings	6,500	13,500	36,000	67,000
Launching facilities needed 1/	160	340	900	1,700
Transient boats 2/				

1/ Launching lanes 12 feet wide or hoists with launching capacity of 40 boats per peak day.

2/ Not applicable in this subregion.

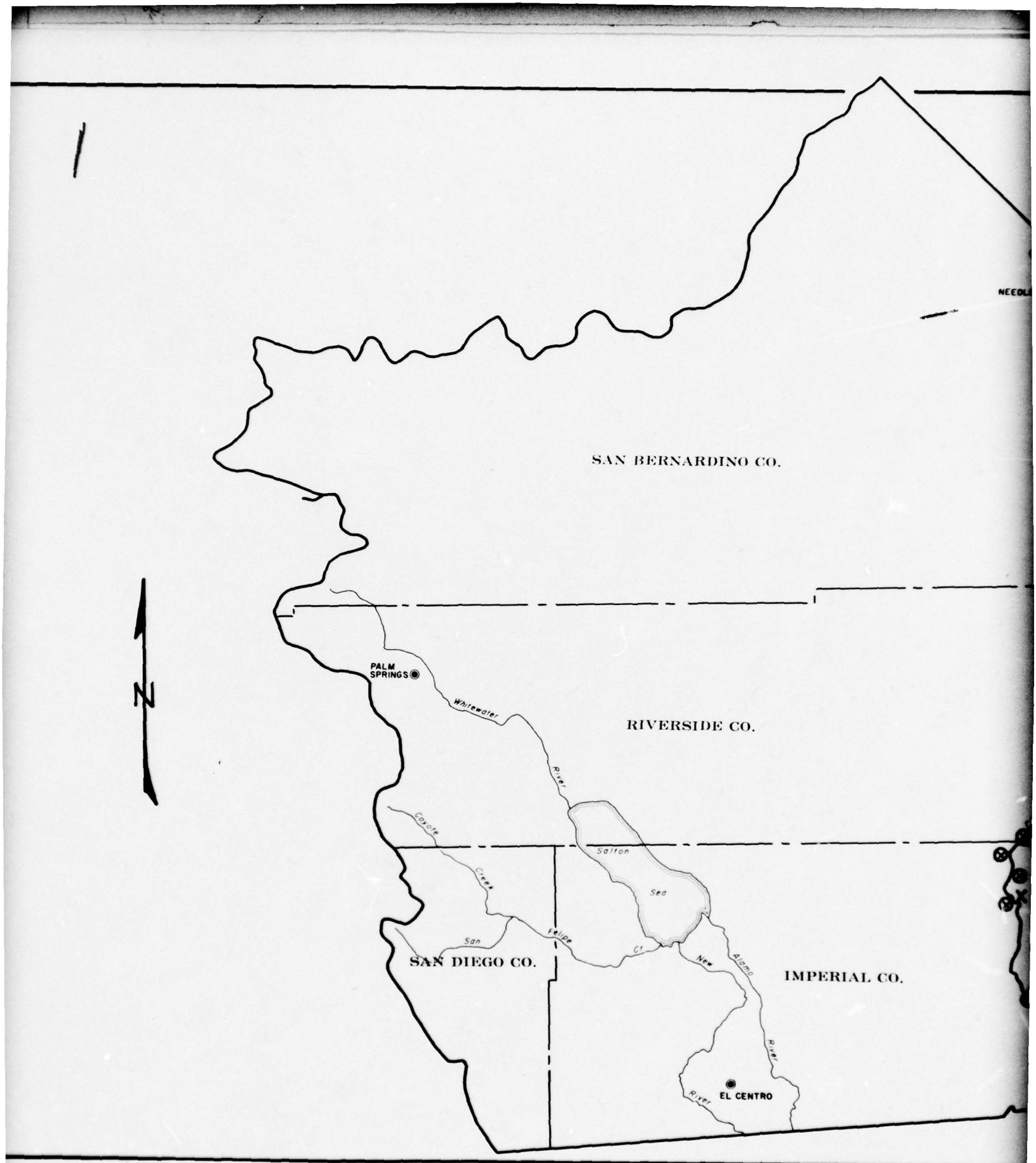
COLORADO DESERT SUBREGION

TABLE CD-2

Summary of Plan to Meet Needs for Recreational Navigation

Feature	As of 1965	1966-1980 Increment	As of 1980	1981-2000 Increment	As of 2000	2001-2020 Increment	As of 2020
Berths							
Needs	425	575	1,000	1,200	2,200	2,300	4,500
Needs met:							
Within facilities existing in 1965	425	0	425	0	425	0	425
Within facilities definitely programmed in 1965	0	0	0	0	0	0	0
Within projected facilities not programmed in 1965	0	575	575	1,200	1,775	2,300	4,075
Incremental additions		575		1,200		2,300	
TOTAL	425		1,000		2,200		4,500
Residual un-met needs	0		0		0		0
Launching lanes							
Needs	160	180	340	560	900	800	1,700
Needs met:							
By lanes existing in 1965	140	0	140	0	140	0	140
By projected lanes	0	200	200	560	760	800	1,560
Incremental additions		200		560		800	
TOTAL	140		340		900		1,700
Residual un-met needs	20		0		0		0
Transient moorings 1/							

1/ Not applicable in this subregion.


SAN BERNARDINO CO.
PALM SPRINGS
Whitewater River
RIVERSIDE CO.
Coyote Creek
Salton Sea
San Felipe Ck
New Alamo River
SAN DIEGO CO.
IMPERIAL CO.
EL CENTRO
River
N

2

LEGEND

O Existing berthing facilities

X Existing launching facilities

NOTE: Location of future facilities not shown

NEEDLES

LAKE HAVASU

PARKER DAM

River

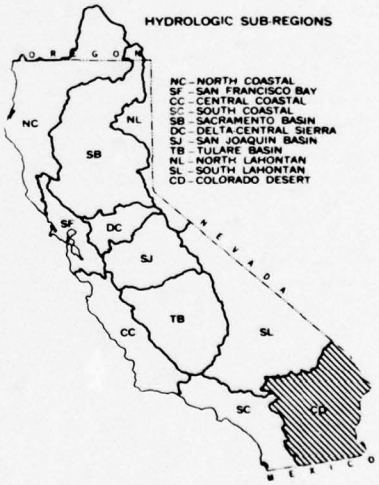
HEADGATE DAM

Colorado

IMPERIAL DAM

LAGUNA DAM

L CO.



MAP CD-1

COLORADO DESERT SUBREGION

CALIFORNIA REGION

RECREATIONAL NAVIGATION DEVELOPMENT

10 0 10 20

SCALE IN MILES

SUPPLEMENTS

SUPPLEMENT A

ALTERNATIVE PROJECTIONS

General

The effects of March 1968 OBERS and Series D 1970 projections upon the future needs for commercial and recreational navigation, the means to satisfy future needs, and the resulting costs are summarized in the following paragraphs. The BASE PLAN, OBERS, and Series D 1970 projections are compared in Tables A-1 through A-4.

OBERS Projection

COMMERCIAL NAVIGATION

Total waterborne commerce for the California Region would be the same under both the OBERS and BASE PLAN projections, but the distribution of waterborne commerce to the Region's various ports would be different. The OBERS projections would result in about 7,640,000 more tons of cargo moving through Los Angeles-Long Beach harbors in the South Coastal subregion by the year 2020. This increase in waterborne commerce at Los Angeles-Long Beach harbors would be offset by corresponding decreases in waterborne commerce at the San Francisco Bay ports and at the ports of the Delta-Central Sierra subregion. The OBERS-based shift in waterborne commerce reflects re-allocation of population-related commodities. Waterborne commerce in the North Coastal and Central Coastal subregions would not be affected because population-related commodities are not appreciably involved. Future waterborne commerce is summarized by subregion and by type of traffic for both the BASE PLAN and OBERS projections in Table A-1.

The commercial navigation requirements for channels, protective works, basins, and levees would be the same as under BASE PLAN projections. Extremely minor readjustments in cargo-handling areas and numbers of berths would be required; these readjustments would be well within the projected capabilities of the commercial navigation improvements presented in the BASE PLAN sections of this report. No modifications in the BASE PLAN cost estimates for commercial navigation facilities are indicated.

RECREATION NAVIGATION

Recreational navigation needs are directly related to population. Based on OBERS population distributions, projected needs would be reduced in most subregions other than the South Coastal subregion. Projected recreational navigation needs are summarized by subregion for both the BASE PLAN and OBERS projections in Table A-2; facilities required to satisfy these needs, by time frames, are summarized in Table A-3. The effects of

the OBERS plan for recreational navigation in inland subregions is less pronounced than in coastal areas, where construction and maintenance costs of harbors are higher. These costs are summarized in Table A-4.

The most significant change resulting from the OBERS population distribution is the greater demand for recreation navigation features in the South Coastal subregion - the subregion least able to satisfy the demand. A plan was developed to satisfy two-thirds of the demand for berthing under the OBERS Plan, the same degree of satisfaction that was satisfied under the BASE PLAN; however, satisfaction of the demand is at a high price, both economically and in terms of the impact on the subregion's environment.

The BASE PLAN utilized to the maximum extent all natural sites considered feasible for recreational navigation facilities. The structures required to satisfy the additional demands in the South Coastal subregion, under the OBERS Plan, would necessarily be located offshore. The most suitable areas are those with relatively shallow water offshore that would permit economical breakwater and fill construction. A possible plan, within the capabilities of present-day construction techniques, is illustrated in Drawing 1.

The effects of such a major modification of the shoreline would require intensive study; however, it is believed that an offshore site would have a relatively less injurious impact upon the subregion's shoreline than would equivalent modification of inland areas.

Series D 1970 Projection

COMMERCIAL NAVIGATION

In the San Francisco Bay subregion the correlation between the March 1968 OBERS and Series D 1970 projections was sufficiently close to permit use of the same waterborne commerce projections. In the South Coastal subregion, the correlation between BASE PLAN and Series D 1970 was sufficiently close to permit use of the same waterborne commerce projections. Some minor variations in commodity projections may occur, however, it is unlikely that overall tonnages, by types of traffic, will vary significantly. The Delta-Central Sierra subregion was re-projected. Waterborne commerce in the North Coastal and Central Coastal subregions would be the same under all three projections.

In the year 2020, total waterborne commerce for the Region under Series D 1970 projections would be about 2.4 percent lower than under the BASE PLAN and OBERS projections. The total population in the Series D 1970 projections is about 18 percent lower than in the BASE and OBERS projections. This disparity reflects movement of substantial quantities of waterborne commerce that are not directly related to the Region's domestic population. Table A-1 summarizes existing waterborne commerce and compares Series D 1970 and BASE PLAN projections of future waterborne commerce.

The commercial navigation requirements for channels, protective works, basins, and levees would be the same as under BASE PLAN projections. Extremely minor readjustments in cargo-handling areas and numbers of berths would be required; these readjustments would be well within the projected capabilities of the commercial navigation improvements presented in the BASE PLAN sections of this report. No modifications in the BASE PLAN cost estimates for commercial navigation facilities are indicated.

RECREATIONAL NAVIGATION

Recreational navigation needs are directly related to population. Based on the 1970 Series D population distributions, projected needs would be reduced from BASE PLAN needs in all subregions other than the South Coastal subregion where needs would stay approximately the same. Projected recreational navigation needs are summarized, by subregion, for both the BASE PLAN and 1970 Series D projections in Table A-2. Facilities required to satisfy these needs, by time frames, are summarized in Table A-3.

The effects on projected costs are summarized in Table A-4.

CALIFORNIA REGION

TABLE A-1

Summary of Existing Waterborne Commerce[1/] and Comparison of BASE PLAN, OBERS and Series D 1970 Projections of Future Waterborne Commerce

Area	1965[2/]	BASE PLAN			OBERS			Series D		
		1980	2000	2020	1980	2000	2020	1980	2000	2020
North Coastal Subregion:[3/]										
Foreign Exports	191	680	780	830						
Foreign Imports	0	0	0	0	Same as BASE PLAN			Same as BASE PLAN		
Coastwise Shipments	297	420	500	570						
Coastwise Receipts	505	1,170	1,600	2,250						
Total	993	2,270	2,880	3,650	2,270	2,880	3,650	2,270	2,880	3,650
San Francisco Bay Subregion:										
Foreign Exports	2,904	3,510	5,190	8,080	3,510	5,190	8,080			
Foreign Imports	6,085	24,220	50,080	88,420	22,210	46,520	82,180			
Coastwise Shipments	8,000	10,420	14,650	20,390	10,420	14,820	21,390			
Coastwise Receipts	11,717	15,700	19,610	21,960	15,700	19,610	21,960	Same as OBERS		
Internal Shipments	9,006	10,160	13,730	18,360	10,160	13,560	17,360			
Internal Receipts	7,738	9,430	13,700	17,240	9,430	13,700	17,240			
Total	45,450	73,440	116,960	174,450	71,430	113,400	168,210	71,430	113,400	168,210
Delta-Central Sierra Subregion:										
Foreign Exports	1,997	3,520	3,950	4,090				3,520	3,950	4,090
Foreign Imports	227	280	400	540				280	390	450
Coastwise Shipments	81	350	420	480	Same as BASE PLAN			350	420	480
Coastwise Receipts	170	360	490	740				360	450	530
Internal Shipments	19	170	240	270				170	240	270
Internal Receipts	2,360	1,750	2,320	3,980				1,750	2,110	2,870
Total	4,854	6,430	7,820	10,100	6,430	7,820	10,090	6,430	7,560	8,690
Central Coastal Subregion:[3/]										
Foreign Exports	0	140	140	140						
Foreign Imports	0	0	0	0	Same as BASE PLAN			Same as BASE PLAN		
Coastwise Shipments	6,351	6,970	7,070	7,090						
Coastwise Receipts	1,072	1,100	1,110	1,120						
Total	7,423	8,190	8,320	8,350	8,190	8,320	8,350	8,190	8,320	8,350

See footnotes at end of table.

Continued

CALIFORNIA REGION

TABLE A-1

Summary of Existing Waterborne Commerce, and Comparison of BASE PLAN, OBERS and Series D 1970 Projections of Future Waterborne Commerce -- Continued

Area	1965[2]	BASE PLAN			OBERS			Series D		
		1980	2000	2020	1980	2000	2020	1980	2000	2020
South Coastal Subregion:[3]										
Foreign Exports	7,913	17,970	25,080	36,480	17,970	25,080	36,480			
Foreign Imports	13,549	19,370	31,640	46,870	21,380	35,460	54,510	Same as BASE PLAN		
Coastwise Shipments	10,431	14,420	19,520	23,450	14,420	19,520	23,450			
Coastwise Receipts	8,409	11,590	15,290	19,810	11,590	15,290	19,810			
Total	40,302	63,350	91,530	126,610	65,360	95,350	134,250	63,350	91,530	126,610
California Region:										
Foreign Exports	13,005	25,820	35,140	49,620	25,820	35,140	49,620	25,820	35,140	49,620
Foreign Imports	19,861	43,870	82,120	135,830	43,870	82,370	137,140	41,860	78,550	129,500
Coastwise Shipments	25,160	32,560	42,160	51,980	32,560	42,330	52,980	32,560	42,330	52,980
Coastwise Receipts	21,873	29,920	38,100	45,880	29,920	38,060	45,670	29,920	38,060	45,670
Internal Shipments	9,025	10,330	13,970	18,630	10,330	13,800	17,630	10,330	13,800	17,630
Internal Receipts	10,098	11,180	16,020	21,220	11,180	15,810	20,110	11,180	15,810	20,110
Grand Total	99,022	153,680	227,510	323,160	153,680	227,510	323,150	151,670	223,690	315,510

1/ Thousands of short tons.
2/ From "Waterborne Commerce of the United States, Part 4, Department of the Army, Corps of Engineers."
3/ Local and internal traffic is not significant in this subregion.

CALIFORNIA REGION

TABLE A-2

Comparison of BASE PLAN, OBERS and Series D 1970 Projections of Recreational Navigation Needs

Area and Facility	BASE PLAN			OBERS			Series D		
	1980	2000	2020	1980	2000	2020	1980	2000	2020
North Coastal Subregion:									
Berths	1,300	2,500	5,300	1,700	2,700	4,100	1,300	1,700	2,200
Launching Lanes	36	66	140	47	73	110	36	46	60
Transient Moorings	900	1,600	3,000	1,200	1,800	2,300	900	1,200	1,700
San Francisco Bay Subregion:									
Berths	22,000	42,000	67,000	20,800	36,500	59,400	21,600	38,000	60,600
Launching Lanes	400	700	1,200	350	610	1,060	390	630	1,080
Transient Moorings	9,000	14,000	23,000	8,700	12,200	20,600	8,800	12,600	21,400
Delta-Central Sierra Subregion:									
Berths	20,700	35,600	49,300	19,500	27,400	38,000	19,800	28,300	38,200
Launching Lanes	120	215	300	110	160	225	120	170	230
Transient Moorings	0	0	0	0	0	0	0	0	0
Sacramento Basin Subregion:									
Berths	1,500	2,750	4,900	1,400	2,100	2,900	1,400	1,800	2,300
Launching Lanes	15	24	38	13	18	22	12	15	17
Transient Moorings	0	0	0	0	0	0	0	0	0
San Joaquin Basin Subregion:									
Berths	290	500	800	290	400	450	310	430	500
Launching Lanes	3	5	8	3	4	5	3	4	6
Transient Moorings	0	0	0	0	0	0	0	0	0
Central Coastal Subregion:									
Berths	4,000	10,400	22,000	3,500	9,700	23,000	3,900	8,800	15,100
Launching Lanes	50	85	140	40	70	100	50	77	107
Transient Moorings	750	2,000	5,000	700	1,800	4,000	750	1,700	3,300
South Coastal Subregion:									
Berths	47,000	90,000	119,000	47,500	99,000	150,000	44,900	86,400	119,600
Launching Lanes	270	560	1,020	280	640	1,380	260	540	1,030
Transient Moorings	6,000	12,000	20,000	6,200	13,800	27,000	5,800	11,500	20,100
Colorado Desert Subregion:									
Berths	1,000	2,200	4,500	925	1,840	4,325	900	1,700	2,400
Launching Lanes	340	900	1,700	380	1,000	1,825	325	860	1,700
Transient Moorings	0	0	0	0	0	0	0	0	0
Total, California Region									
Berths	97,790	185,950	272,800	95,615	179,640	282,175	94,110	167,130	240,900
Launching Lanes	1,234	2,555	4,546	1,223	2,575	4,727	1,196	2,342	4,230
Transient Moorings	16,650	29,600	51,000	16,800	29,600	53,900	16,250	27,000	46,500

CALIFORNIA REGION

TABLE A-3

Summary of BASE, OBERS and Series D 1970 Plans to Meet Needs for Recreational Navigation

Feature	1965	BASE PLAN			OBERS			Series D		
		1980	2000	2020	1980	2000	2020	1980	2000	2020
Berths										
Needs	51,545	97,790	185,950	272,800	95,615	179,640	282,175	94,110	167,130	240,900
Needs met:										
Within facilities existing in 1965 1/	41,225	48,010	48,710	48,710	48,010	48,710	48,710	48,010	48,710	48,710
Within facilities definitely programmed in 1965	0	12,075	15,375	16,875	12,075	15,375	16,875	12,075	15,375	16,875
Within projected facilities not programmed in 1965	0	31,415	113,415	196,715	30,740	107,665	199,350	28,715	97,215	168,615
TOTAL	41,225	91,500	177,500	262,300	90,825	171,750	264,935	88,800	161,300	234,200
Residual un-met needs	10,320	6,290	8,450	10,500	4,790	7,890	17,240	5,310	5,830	6,700
Launching lanes										
Needs	633	1,234	2,555	4,546	1,243	2,575	4,727	1,196	2,342	4,230
Needs met:										
By lanes exisiting in 1965	762	762	757 3/	752 3/	762	757 3/	752 3/	762	757 3/	752 3/
By projected lanes	0	548	1,779	3,739	564	1,856	3,859	533	1,744	3,669
TOTAL	762	1,310	2,536	4,491	1,326	2,613	4,611	1,295	2,501	4,421
Residual un-met needs	0	0	19	55	0	0	116	0	0	0
Transient moorings										
Needs	9,250	16,650	29,600	51,000	16,800	29,600	53,900	16,250	27,000	46,500
Needs met:										
By moorings existing in 1965	7,900	7,900	7,900	7,900	7,900	7,900	7,900	7,900	7,900	7,900
By projected moorings 2/	0	8,750	21,700	43,100	9,000	21,300	40,400	8,350	19,200	38,700
TOTAL	7,900	16,650	29,600	51,000	16,900	29,200	48,300	16,250	27,100	46,600
Residual un-met needs	1,350	0	0	0	0	400	5,600	0	0	0

1/ To be developed through self-liquidating improvements not included in cost estimates.
2/ Including mooring to be developed in Baja California, Mexico.
3/ Includes obsolescence of lanes existing in 1965.

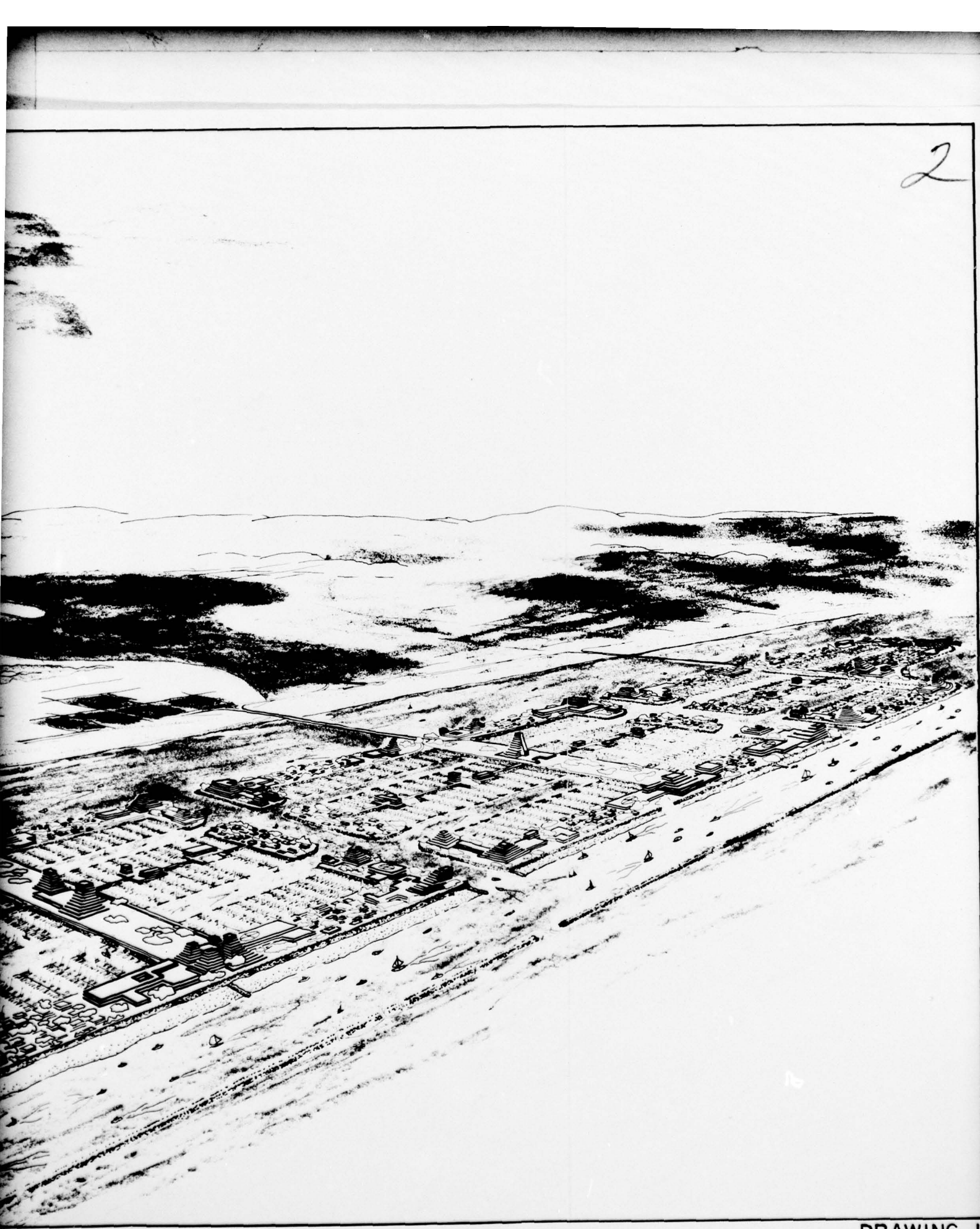
CALIFORNIA REGION

TABLE A-4

Comparison of Installation Costs, in Millions, for BASE PLAN, OBERS and Series D 1970 Navigation Facilities

Area	BASE PLAN				OBERS				Series D			
	1966-1980	1981-2000	2001-2020	Total 1966-2020	1966-1980	1981-2000	2001-2020	Total 1966-2020	1966-1980	1981-2000	2001-2020	Total 1966-2020
	Commercial Navigation Facilities											
North Coastal Subregion	5.1	6.6	14.6	26.3								
San Francisco Bay Subregion	102.0	233.0	255.0	590.0								
Delta-Central Sierra Subregion	46.8	40.7	32.1	119.6								
Sacramento Basin Subregion	0	78.0	0	78.0	Same as BASE PLAN				Same as BASE PLAN			
San Joaquin Basin Subregion	0	0	0	0								
Central Coastal Subregion	0	0	0	0								
South Coastal Subregion	211.4	246.0	272.0	729.4								
Colorado Desert Subregion	0	0	0	0								
TOTAL, Region	365.3	604.3	573.7	1,543.3	365.3	604.3	573.7	1,543.3	365.3	604.3	573.7	1,543.3
	Recreational Navigation Facilities											
North Coastal Subregion	3.7	15.7	41.0	60.4	9.0	14.1	25.7	48.8	3.7	5.7	10.5	19.9
San Francisco Bay Subregion	24.0	50.0	70.0	144.0	20.9	40.0	63.0	123.9	23.0	40.0	62.4	125.4
Delta-Central Sierra Subregion	8.3	21.0	13.0	42.3	8.3	15.0	11.0	34.3	8.3	16.0	10.0	34.3
Sacramento Basin Subregion	.2	1.4	1.8	3.4	.2	1.0	.7	1.9	.2	.7	.4	1.3
San Joaquin Basin Subregion	0	.2	.3	.5	0	.2	.3	.5	0	.2	.3	.5
Central Coastal Subregion	31.7	36.6	23.5	91.8	31.7	31.5	8.7	71.9	31.7	28.2	12.8	72.7
South Coastal Subregion	64.2	170.0	200.0	434.2	64.2	218.0	356.0	638.2	64.2	145.0	200.0	409.2
Colorado Desert Subregion	2.4	6.3	12.2	20.9	2.4	6.3	12.2	20.9	2.4	6.3	12.2	20.9
TOTAL, Region	134.5	301.2	361.8	797.5	136.7	326.1	477.6	940.4	133.5	242.1	308.6	684.2
	Total, All Navigation Facilities											
California Region	499.8	905.5	935.5	2,340.8	502.0	930.4	1,051.3	2,483.7	498.8	846.4	882.3	2,227.5

2



DRAWING 1

SUPPLEMENT B

GLOSSARY

ANADROMOUS	Pertaining to fish that spend a part of their life cycle in salt water and migrate into fresh-water streams to spawn.
BERTHED, BERTHING	A type of wet storage where a vessel is docked in a "U"-shaped slip, or tied alongside a wharf or slip.
BREAKWATER	A structure protecting a harbor, anchorage or basin from waves.
CARGO HANDLING:	
CONTAINER	Truck-body sized vans which can be carried aboard ship. Containers are designed for multi-modal transport and are pre-loaded before transport.
DRY BULK	Dry cargo placed into the hold of a ship, without packaging, by blower, conveyor belt or clam shell bucket.
LIQUID BULK	Fluid cargo placed into the hold of a ship, without packaging, by pump and pipe line.
BREAK BULK	Cargo handled by port crane or shipboard boom. Each load is assembled manually on the dock or in the hold before being transferred in or out of the ship.
COMMERCIAL FISHING BOATS	Boats which are used to catch fish for sale.
CONTROLLING DEPTH	The least depth of water in navigable parts of a waterway, which limits the allowable draft of vessels.
DEEP DRAFT	Vessels with drafts greater than 15 feet.

DESIGN VESSEL	The prototype vessel for which a specific waterway is designed. The dimensions of this vessel are used in determining channel depth, width, and turning area requirements.
EQUIVALENT LANE	The measure of capacity of a launching facility equal to the number of boats that can be launched at the same time from the facility. A hoist, crane or other mechanical device is equivalent to one lane of a launching ramp.
INLAND WATERS	Those waters that are in fact navigable by water craft and are wholly within the jurisdiction of state government.
JETTY	A structure extending into the body of water on estuary or open sea coast and which is designed to prevent shoaling of a channel by littoral material and to direct or confine stream or tidal flow.
LASH	From "Lighter-aboard-ship". A shipping system involving large ocean-going vessels designed for carrying preloaded lighters or barges, lifted aboard like big containers at the start of an ocean passage and returned to the water at its end to proceed to their final destination independent of the mother ship.
LAUNCHING FACILITY	Refers to a launching ramp or a mechanical device, such as a crane, hoist or marine railway, designed for placing trailered boats in and retrieving them from the water.
LIGHT DRAFT	Vessels with drafts up to 15 feet.
MARINA	A complete recreational harbor, including the protective works, boating facilities, and shore developments, such as restaurants, hotels, and services.
MOORING	A type of wet storage where a vessel is secured to a permanently anchored buoy.
NAVIGABLE WATERS	Those waters that are in fact navigable by water craft and which fall within the regulatory jurisdiction of the Army Corps of Engineers.

OPERATION, MAINTENANCE AND REPLACEMENT COSTS (OM & R)	The value of goods and services needed to operate a construction project and make repairs and replacements necessary to maintain the project in sound operating condition during its economic life.
RECREATIONAL BOATS:	
BERTHABLE	Pleasure craft permanently kept in water. This study assumes that all boats 21 feet in length, 75 percent of those 19 to 21 feet in length and 50 percent of those 17 to 19 feet in length, are berthable.
TRAILERED	Pleasure craft that are kept in dry storage when not in use.
REQUIREMENTS	The goods, services or resources necessary to fulfill a specified projection. The willingness or capability of this sector of economy to satisfy the projection is not a factor in requirement.
SERVICE AREA	The geographic area served by the function or functions under discussion; also called tributary area.
SPORT FISHING BOATS	Commercially operated boats used to haul sport fishermen on boating trips. Also called party boats.
VESSEL DRAFT	The depth of a vessel from its water line to the deepest part of its keel.
WATERBORNE COMMERCE:	
IMPORTS AND EXPORTS	Maritime traffic between the United States and foreign ports.
COASTWISE RECEIPTS AND SHIPMENTS	Maritime traffic between United States continental ports, possessions and territories.
WETLANDS	Low land areas that are usually covered with shallow or intermittent water, often referred to as marshes, swamps, sloughs or lagoons.

SUPPLEMENT C

SELECTED BIBLIOGRAPHY

General Reports

California and Use of the Ocean, A Planning Study of Marine Resources, Institute of Marine Resources, University of California, La Jolla, 1965.

California Small Craft Harbors and Facilities Plan, Leeds, Hill and Jewett for Dept. of Parks and Recreation, State of California, 1964.

Compilation of Recommendations of the Governor's Advisory Commission on Ocean Resources, January 1965-January 1967, State of California Dept. of Finance.

"Design of Channels for Navigation", Chap. X, Report No. 3, Evaluation of the Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomena, Committee on Tidal Hydraulics, Corps of Engineers, 1965.

Harbor and Port Development, A Problem and an Opportunity, Corps of Engineers, July 1968.

Interim Report on Coastal Harbors of Refuge, Leeds, Hill and Jewett for Dept. of Parks and Recreation, State of California, 1953.

Inventory of Boating Facilities, Dept. of Harbors and Watercraft, State of California, 1966.

Oceanborne Shipping: Demand and Technology Forecast, Litton Systems Inc. for the U.S. Dept. of Transportation, 1968.

"Prediction of Maximum Practical Berth Occupancy" by Fratar, Goodman and Brant, Journal of the Waterways and Harbors Division, Proceedings of the A.S.C.E., June 1960.

A Preliminary Study Plan for Assessing Long Range Effects of Regional Harbor Development, prepared for U.S. Army Engineer District San Francisco by the Stanford Research Institute, 1969.

Report on Small Craft Harbors, A.S.C.E., Manuals and Reports on Engineering Practice - No. 50, 1969.

United States Coast Pilot 7, Pacific Coast, G.P.O., 1968.

Waterborne Commerce of the United States, Part 4, Dept. of the Army, Corps of Engineers.

Water Resources Development of the U.S. Army Corps of Engineers in California, South Pacific Division, Corps of Engineers, January 1969.

Reports Relating to Specific Locations

NORTH COASTAL SUBREGION

Master Plan of Small Craft Harbors for Sonoma County, California, Sonoma County Planning Commission, 1957.

Mendocino County, California, General Plan, Planning Division, Department of Public Works, Mendocino County.

SAN FRANCISCO BAY SUBREGION

Golden Gate Atlas, First Edition, Marine Exchange, San Francisco, California, 1969.

Preliminary Plan of Study of San Francisco Bay, In-Depth Study, San Francisco District Corps of Engineers, 1969.

Report of Survey on San Francisco Bay and Tributaries, California, San Francisco District Corps of Engineers, 1967.

San Francisco Bay Plan, San Francisco Bay Conservation and Development Commission, 1969.

Technical Report on Barriers, San Francisco District Corps of Engineers, July 1963.

DELTA-CENTRAL SIERRA, SACRAMENTO BASIN AND SAN JOAQUIN BASIN SUBREGIONS

Application Before Economic Development Administration for Grants and Loans for the Expansion and Development of Docks and Warehouse Facilities at the Port of Stockton, June 1967.

Sacramento River, Calif. (Deep Water Ship Channel) Senate Doc. 142, 79th Cong., 2d sess.

San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels), Public Law 298, 89th Cong., 1st sess., 27 Oct. 1965.

Recreation Appendix to Bulletin No. 76, Delta Water Facilities, State of Calif., Dept. of Water Resources, Aug. 1962.

Sacramento - San Joaquin Delta Navigation Report, Phase I, Parsons, Brinckerhoff, Hall and McDonald Engineers.

Sacramento - San Joaquin Delta Master Recreation Plan, State of California, June 1966.

A Proposal for Flood Control and Recreational Development in the Sacramento San Joaquin Delta, Corps of Engineers, 1966.

The General Plan, Sacramento County, 1965.

Preliminary Recreation Element of the General Plan for San Joaquin County, Section II, Delta, October 1965.

CENTRAL COASTAL SUBREGION

Feasibility Study for Morro Bay Harbor, Moffatt and Nichol for San Luis Obispo County, 1962.

Review Report for Navigation, Port San Luis, Los Angeles District Corps of Engineers, 1961.

General Navigation Features of the Harbor for Santa Barbara Bayshores at Goleta, Calif., Omar J. Lillevang, 1965.

Review Report for Navigation, Santa Barbara Harbor, H. Doc. 518, 87th Cong., 2d sess., G.P.O., 1962.

Santa Barbara Harbor Expansion, Morgan Noble et al, 1967.

SOUTH COASTAL SUBREGION

Survey Report for Navigation, Ventura Marina, Los Angeles District Corps of Engineers, 1968.

General Design for Harbor and Shore Protection Works Near Port Hueneme, Calif., Design Memorandum No. 1, Los Angeles District Corps of Engineers, 1968.

The Santa Monica Causeway, Moffatt and Nichol, 1964.

General Design for Marina del Rey, Design Memorandum No. 2 (Revised), Los Angeles District Corps of Engineers, 1963.

Review Report on Redondo Beach Harbor, H. Doc. 303, 81st Cong., 1st sess., G.P.O., 1949.

Annual Reports, Port of Los Angeles, 1950 through 1969.

The Ports of Los Angeles and Long Beach, Calif., Port Series No. 28, Corps of Engineers, G.P.O., 1968.

Comprehensive Report, Port of Long Beach, 1965.

Preliminary Report on Sunset Harbor, Orange County Harbor District, 1965.

Improvement of Upper Newport Bay, Newport Harbor, Orange County, Calif., Orange County Board of Supervisors and Orange County Harbor Commission, 1950.

Dana Point Harbor, H. Doc. 532, 87th Cong., 2d sess., G.P.O., 1962.

Survey Report for Navigation, Oceanside Harbor, Los Angeles District Corps of Engineers, 1963.

Definite Project Report on San Diego River and Mission Bay, Calif., Addendum No. 1, Los Angeles District Corps of Engineers, 1958.

Interim Review of Reports for Navigation, San Diego Harbor, Los Angeles District Corps of Engineers, 1967.

The Port of San Diego, Port Series No. 27, Corps of Engineers, G.P.O., 1956.

Imperial Beach, Calif., Small Craft Harbor, Moffatt and Nichol for the City of Imperial Beach, 1958.

COLORADO DESERT SUBREGION

Inventory of Recreation Facilities, Lower Colorado River Land Use Office, Yuma, Arizona, 1967.

The Lower Colorado River Land Use Plan, U.S. Dept. of the Interior, January, 1964.

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